A rear-operated, articulated floor scrubber (24) is disclosed. In one embodiment, the scrubber (24) comprises a front portion (28), a rear portion (28) that is pivotally connected to the front portion (26), and an operator interface (38) associated with the rear portion (28). The scrubber (24) further comprises a solution tank (40) for holding cleaning solution and a recovery tank (42) for holding cleaning solution and entrained debris that is picked up from the floor after the floor has been scrubbed. In one embodiment, a portion (26, 28) of one of the tanks (40, 42) overlies a portion (26, 28) of the other tank (40, 42).
ARTICULATED FLOOR SCRUBBER

FIELD OF THE INVENTION

[0001] The invention relates to floor scrubbing machines that apply a cleaning liquid to a floor to be cleaned, scrub the floor to which the cleaning liquid has been applied, and remove liquid and entrained debris from the floor after the floor has been scrubbed. More specifically, the present invention relates to an articulated floor scrubber that comprises a front portion and a rear portion that are pivotally connected to one another.

BACKGROUND OF THE INVENTION

[0002] U.S. Pat. No. 5,742,975 discloses an articulated floor scrubber that has a wheel-supported front portion that is pivotally connected to a wheel-supported rear portion. Associated with the front portion are an operator’s seat, a steering wheel, a forward/reverse foot-pedal, a brake foot-pedal and a control panel. A steering linkage that utilizes a cable and pulley system operates such that counterclockwise (CCW) rotation of the steering wheel produces a left-turn of the scrubber and clockwise (CW) rotation of the steering wheel produces a right-turn of the scrubber. Also associated with the front portion is a solution tank that holds a cleaning solution and a scrub head. In operation, cleaning solution from the solution tank is applied to the floor that is to be cleaned and the scrub head is used to engage the floor to which the cleaning fluid has been applied. Associated with the rear portion is a vacuum squeegee for vacuuming up liquid and entrained debris from the floor, and a recovery tank that holds the liquid and entrained debris vacuumed up by the vacuum squeegee. Also associated with the rear portion is an electric motor for driving the rear wheels of the scrubber and a number of batteries for providing power to the electric motor.

[0003] A typical articulated walk-behind floor scrubber 10 is shown in FIG. 1. Scrubber 10 is a single-unit or monolithic device that includes: (a) an operator interface 12 that is located at the rear of the scrubber; (b) two laterally-displaced and non-steerable, front wheels 14, associated with each wheel is a tire that is typically about 10 to 12 inches in diameter; and (c) two laterally-displaced casters 16 that freely rotate on horizontal axes, freely swivel on vertical axes, and are located behind the front wheels 12. If scrubber 10 is self-propelled, the front wheels 14 are driven by a battery-powered electric motor (not shown). In some cases, the electric motor is also capable of differential speed control that, in response to an operator’s actuation of a steering wheel or other steering interface, allows the front wheels to rotate at different speeds to turn the scrubber. Many such scrubbers are not self-propelled or are self-propelled but do not have differential speed control. In these types of scrubbers, steering is accomplished by the operator pushing the rear of the scrubber to the right or left. The typical articulated walk-behind floor scrubber also includes a solution tank (not shown) for holding a cleaning solution, a scrub head 18 that is located in front of the front wheels 14, a vacuum squeegee 20 that is located behind the casters, and a recovery tank (not shown) that each function in substantially the same manner as noted with respect to the articulated floor scrubber described above. Typically, the solution tank and the recovery tank are located so that one is entirely located above the other. In the scrubbers that are self-propelled, the electric motor is typically located adjacent to the front wheels 14. The battery or bank of batteries that is used to power the electric motor is located between the front positioned solution tank and the rear positioned recovery tank with all or the majority of the mass of the battery or bank of batteries positioned between the front wheels 14 and the casters 16.

[0004] Prior art walk-behind scrubbers, such as the one shown in FIG. 1, reflect a compromise between the desire to maximize the operating range of the scrubber (by maximizing the capacities of the solution and recovery tanks and maximizing the battery power) and the need to easily maneuver the scrubber in small spaces or around posts or the like. In this regard, some walk-behind scrubbers, when a fully loaded, weigh as much as one thousand pounds. However, as the weight of the scrubber increases, fine steering control becomes more difficult, particularly when attempting to steer in tight quarters and/or when steering is accomplished by physically pushing the rear of the scrubber to the right or left. Further, in some situations, such scrubbers are so difficult to maneuver that the floor is more efficiently cleaned by hand mopping. As a consequence, prior art walk-behind floor scrubbers can adversely affect productivity, especially if operated over long periods of time and/or the floor being cleaned requires substantial maneuvering of the scrubber.

SUMMARY OF THE INVENTION

[0005] In one embodiment, the present invention provides a rear-operated and articulated floor scrubber that comprises a front scrubber portion having a first pair of wheels, a rear scrubber portion having a second pair of wheels, a pivot joint that mechanically connects the front scrubber portion to the rear scrubber portion and allows pivotal movement between the front scrubber portion and rear scrubber portion, and an operator interface associated with the rear scrubber portion that comprises a steering interface, such as a steering wheel. The invention further comprises a steering linkage that, in response to actuation of the steering interface, causes pivotal movement to occur between the front and rear portions of the scrubber.

[0006] In one embodiment, the steering linkage comprises a sprocket, a chain, cable and pulley system that translates rotation of a steering wheel into rotation of the front portion of the scrubber about the pivot joint. One embodiment of this linkage avoids the use of the dual groove pulley used in the steering linkage employed in the U.S. Pat. No. 5,742,975 patent. Other types of mechanical steering linkages are feasible, including linkages that employ pneumatic and/or hydraulic components. Also feasible are steering linkages that employ electrical components. For example, a steering linkage that employs an electrical motor to apply a force that causes rotation of the front portion about the pivot joint is feasible.

[0007] In another embodiment, a steering wheel is employed and the steering linkage comprises a steering wheel axle that is operatively connected to the steering wheel. The steering wheel axle lies substantially in a horizontal plane, i.e., within a range that is approximately +/- 15 degrees of horizontal.

[0008] In yet a further embodiment, the scrubber comprises a front scrubber portion having a first pair of wheels,
a rear scrubber portion having a second pair of wheels, a pivot joint that mechanically connects the front scrubber portion to the rear scrubber portion and allows pivotal movement between the front scrubber portion and rear scrubber portion, an operator interface that comprises a steering interface, a solution tank associated with one of the front scrubber portion and the rear scrubber portion, a recovery tank associated with the other of the front scrubber portion and rear scrubber portion, and with the solution and recovery tanks arranged such that at least a portion of one of the tanks extends above at least a portion of the other tank.

In another embodiment, portions of one tank extend above and to the side of the other tank. In one embodiment, portions of the recovery tank extend above and to the side of the solution tank. In a further embodiment, portions of a first tank extend above and to the side of the second tank and portions of the second tank extend below and to the side of the first tank. In another embodiment, the vertical axis of rotation associated with the pivot joint passes through the overlapping portions of the two tanks. In yet a further embodiment, each of the tanks includes a curved surface, with at least a portion of each surface having a center of curvature that is coincident with the vertical axis of rotation. In yet another embodiment, each of the tanks includes two, curved surfaces with at least a portion of each curved surface having a center of curvature that is coincident with the vertical axis of rotation.

An additional embodiment of the scrubber comprises a battery or bank of batteries that are located within the front scrubber portion. Positioning a battery or bank of batteries in the front scrubber portion allows at least a portion of the battery or bank of batteries to be used to apply a force to the scrub head when the scrub head is in use.

Yet a further embodiment of the scrubber comprises a drive system that is associated with the front scrubber portion and applies a driving force to the first pair of wheels.

In another embodiment of the scrubber, the second pair of wheels, the pair associated with the rear scrubber portion, employ pneumatic tires that are of a greater width than the casters used in prior art walk behind scrubbers. The use of wider pneumatic tires has a number of advantages relative to the prior art casters. Namely, due to the greater footprint of the tires relative to casters, less pressure is transmitted to the floor by the tires, thereby reducing the possibility of damaging the floor. Additionally, the tires are noticeably less noisy than casters. In another embodiment, all four wheels employ pneumatic tires.

In a further embodiment, the first and second pairs of tires are located further from one another than prior art walk-behind scrubbers of comparable overall length. As a consequence, the scrubber is more stable than prior art walk-behind scrubbers.

A further embodiment of the scrubber allows an operator to stand on a platform associated with the rear scrubber portion. Yet another embodiment allows the operator to assume a sitting position adjacent the rear scrubber portion.

**DETAILED DESCRIPTION**

With reference to FIGS. 2A-2C, an embodiment of a rear-operated articulated floor scrubber 24 is described. The scrubber 24 comprises a front portion 26 and a rear portion 28 that is pivotally attached to the front portion 26. Associated with the front portion 26 is a pair of non-steerable front wheels 30 and a scrub head 32. Associated with the rear portion 28 is a pair of non-steerable rear wheels 34 and a vacuum squeegee assembly 36. Also associated with the rear

**FIGS. 2A-2D** respectively show right side, rear, top and bottom views of an embodiment of a rear-operated articulated floor scrubber.

FIG. 3 is a side view that illustrates some of the internal components of the scrubber shown in FIGS. 2A-2D.

FIGS. 4A-4C respectively illustrate the scrubber shown in FIGS. 2A-2D with the front portion and back portion positioned for straight ahead operation, a moderate right turn, and an extreme right turn.

FIG. 5 illustrates the scrubber shown in FIGS. 2A-2D in a system of narrow aisles in which the scrubber is in straight ahead operation followed by an extreme left turn and an extreme right turn.

FIG. 6 illustrates the scrubber shown in FIGS. 2A-2D turning around a post of relatively small diameter.

FIGS. 7A-7E respectively are right side, front, rear, top and bottom views of the solution tank of the scrubber shown in FIGS. 2A-2D.

FIGS. 8A-8B respectively are lateral and longitudinal cross-sections of the solution tank shown in FIGS. 7A and 7D.

FIGS. 9A-9E respectively are right side, front, rear, top and bottom views of the recovery tank of the scrubber shown in FIGS. 2A-2D.

FIG. 10 is a longitudinal cross-section of the recovery tank shown in FIG. 9C.

FIGS. 11A-11C respectively are rear, side and top views of a steering linkage associated with the scrubber shown in FIGS. 2A-2D.

FIG. 12 illustrates the manner in which a cable associated with the steering linkage is attached to a plate.

FIG. 13 is a top view of the solution tank and recovery tank when the scrubber of FIGS. 2A-2D is in a full right turn.

FIG. 14 is a bottom view of the solution tank and recovery tank when the scrubber of FIGS. 2A-2D is in a full right turn.

FIG. 15 illustrates a second embodiment of the scrubber of the present invention that comprises a rear-mounted platform that allows an operator to ride on the scrubber rather than walk behind the scrubber.

FIG. 16 illustrates a third embodiment of the scrubber of the present invention that comprises a rear mounted seat that allows an operator to ride on the scrubber rather than walk behind the scrubber.
portion 28 is an operator interface 38 that allows an operator to steer the scrubber 24 and otherwise control the scrubber 24.

[0031] With reference to FIG. 3, the scrubber 24 further comprises a solution tank 40 for holding a cleaning solution (e.g., water, soap and water etc.) and a recovery tank 42 for holding whatever cleaning solution and entrained debris that the vacuum squeegee 36 picks up from a floor. The solution tank 40 is associated with the front portion 26 of the scrubber 24. The recovery tank 42 is associated with the rear portion 28 of the scrubber 24. Operatively connected to the front wheels 14 is an electric motor assembly 44 that is responsive to signals generated from an operator’s use of the operator interface 38. Generally, the electric motor 44 is responsive to signals that cause the electric motor 44 to drive the front wheels 14 in either a forward or reverse direction and to drive the front wheels 14 at a desired speed. The electric motor incorporates a differential that allows the front wheels 14 to turn at different rotational speeds during a turn. A power supply 46 that provides the electric motor 44 with power is associated with the front portion 26 of the scrubber 24. A vacuum pump 48 that is part of the vacuum squeegee 36 is associated with the rear portion 28 of the scrubber 24.

[0032] With continuing reference to FIG. 3, the scrubber 24 further comprises a vertical pivot mechanism 50 that serves to both connect the front portion 26 to the rear portion 28 and to allow relative pivoting movement between the front and rear portions. Pivoting is achieved using a steering interface device 52 that allows an operator to take actions that result in the scrubber 24 being steered in a particular direction and a steering linkage 54 that links the steering interface device 52 to the vertical pivot mechanism 50.

[0033] With reference to FIGS. 4A-4C, the turning operation of the scrubber 24 is generally described. In FIG. 4A, the steering interface device 52 is oriented such that the front portion 26 is aligned with the rear portion 28 and that upon the application of power to the front wheels 30, the scrubber 24 will move either straight forward or straight backward depending on the setting of a forward/reverse interface device. In FIG. 4B, the steering interface device 52 has been manipulated and the steering linkage 54 has responded to the manipulation so that the front portion 26 has been rotated approximately 30 degrees in a clockwise direction relative to the rear portion 28. Consequently, when or if power is applied to the front wheels 30 and assuming that the scrubber is set for forward operation, the scrubber 24 will make a moderate right turn. In FIG. 4C, the steering interface device 52 has been manipulated and the steering linkage 54 has responded to the manipulation so that the front portion 26 has been rotated approximately 65 degrees in a clockwise direction relative to the rear portion of the scrubber, the maximum rotation possible for this particular embodiment. Consequently, when or if power is applied to the front wheels 30 and assuming that the scrubber is set for forward operation, the scrubber 24 will make a hard right turn. As should be appreciated, the scrubber 24 is capable of making right turns over a range that is greater than 0 degrees and less than or equal to 65 degrees. The scrubber 24 is also capable of making left turns over a range that is greater than 0 degrees and less than or equal to 65 degrees. Modification of the scrubber to achieve a greater or lesser turning range is possible.

[0034] FIG. 5 illustrates the scrubber 24 proceeding through a series of aisles that require, in sequence, straight-forward operation, a hard left turn, and a hard right turn. FIG. 6 illustrates the scrubber 24 making a hard right turn in which the scrubber 24 is able to repeatedly circumnavigate a post 58 that is approximately 4" in diameter. FIGS. 5 and 6 illustrate the high degree of maneuverability of the scrubber 24 that, among other things, reduces the amount of hand mapping that is required to fully clean a floor that requires a high number of turns of a scrubber (e.g., a floor with aisles and the like) and/or obstacles (e.g., posts and the like).

[0035] Having described the basic features and maneuverability of the scrubber 24, the scrubber 24 is now described in greater detail. However, before describing the scrubber 24 in greater, it should be appreciated that numerous variations of the elements that comprise the scrubber 24 are feasible, provided the functionality of a scrubber is substantially preserved.

[0036] With reference to FIG. 3, the front portion 26 comprises a front frame 62 that serves as a structure to which other components of the front portion 26 are attached. To elaborate, the front wheels 30, scrub head 32, solution tank 40, electric motor assembly 44, power supply 46, and vertical pivot axis mechanism 50 are each directly, indirectly or operatively attached to the front frame 62.

[0037] In the illustrated embodiment, the electric motor assembly 44 comprises an electric motor 64 and a transaxle 66. The transaxle comprises a transmission 68, drive axle 70 to which the front wheels 30 are attached, and a differential 72. The transmission 68 serves to transmit power from the electric motor 64 to the drive axle 70. The differential 72 allows the front wheels 30 to turn at different rotation speeds when the scrubber 24 is in a turn.

[0038] The power supply 46 for providing electrical energy to the electric motor is comprised of a bank of six batteries 74 in the illustrated embodiment. The power supply 46 is capable of being modified to comprise a greater or lesser number of batteries in other embodiments of the invention. It should also be appreciated that the power supply 46 is not limited to one or more batteries. For instance, the power supply 46 can also include one or more fuel cells. Combinations of power sources, such as one or more batteries and one or more fuel cells, are also feasible. Further, if the volume occupied by the power supply 46 in the illustrated embodiment is reduced for whatever reason, it should be appreciated that the volume that is no longer being used for the power supply 46 can be allocated to other elements of the scrubber 24. For instance, the volume of the solution tank 40 can be increased. In the case in the power supply 46 is comprised of a bank of batteries, such as the bank of six batteries 74, the center of gravity of the bank of batteries can be placed forward of the center of gravity of a comparable bank of batteries in an scrubber that is not articulated. The ability to move the center of gravity forward enhances the stability of the scrubber 24 relative to many of the known walk-behind scrubbers.

[0039] The scrub head 32, in the illustrated embodiment, comprises left and right scrubbing brushes 76A, 76B, a left scrub head motor 78A that rotates the left scrubbing brush in a clockwise direction, a right scrub head motor 78B that rotates the right scrubbing brush in a counter-clockwise direction, and a vertical displacement mechanism 80 that
allows the operator to move the left and right scrubbing heads out of and into engagement with a floor. In the illustrated embodiment, the vertical displacement mechanism 80 comprises an electrical motor 82, lead screw 84, and a cross-bar 86 that is operatively connected to the scrub head motors 78A, 78B. The operator interface 38 comprises a scrub head interface that allows the operator to specify whether the scrubbing brushes 76A, 76B are to be displaced towards or away from the floor. In operation, depending on the operator input, the motor 82 drives the lead screw 84 such that the cross-bar 86, together with the motors 78A, 78B and scrubbing brushes 76A, 76B, is displaced towards or away from the floor. The operator interface 38 also provides an interface for allowing the operator to activate and deactivate the scrub head motors 78A, 78B. It should be appreciated, that the scrub head 32 is not limited to the illustrated type of scrub head. For instance, the scrub 32 can comprise only one brush scrub in a particular embodiment or more than two brush scrub in other embodiments. Further, the scrub head 32 can also comprise one or more cylindrical brushes that rotate about an axis that is substantially parallel to the floor. The scrub head 32 can also comprise mixtures of one or more types of scrubbing brushes. Additionally, the scrub head 32 can employ other structures for displacing a scrub head or heads towards and away from the floor. For instance, structures that are strictly mechanical (i.e., do not employ an electrical component) are feasible. Mechanical structures that employ hydraulic, pneumatic or combinations of hydraulic and pneumatic components are feasible. Other electro-mechanical structures are also feasible.

With reference to FIGS. 7A-7F and 8A-8B, the solution tank 40 is a single tank. The solution tank 40 could be comprised of multiple tanks. However, a multiple tank design is generally more costly to manufacture and more difficult to operate. With reference to FIG. 2C, solution tank 40 has an inlet cap 88 that is removed to load the tank with a cleaning solution 40. An inlet hatch 90 is removed if access is needed to the interior of the tank 40 for cleaning and the like. The solution tank 40 also comprises one or a pair of drains (not shown) that, under operator control, provide cleaning solution that the scrub head 32 uses in cleaning a floor surface during operation.

With continuing reference to FIGS. 7A-7F and 8A-8B, the solution tank 40 is substantially symmetrical about its longitudinal axis. Generally, this provides a substantially even lateral distribution of cleaning solution related weight that facilitates the steering of the scrubber 24. The solution tank 40 is comprised of a top portion 92, rear portion 94, and right and left side portions 96A, 96B. A void space 98 is defined by the top portion 92, the rear portion 94, and the right and left side portions 96A, 96B. The void space 98 is occupied by the power supply 46, as shown in FIG. 3. Should the space occupied by the power supply 46 decreases the shape of the solution tank 40 can be altered to utilize any space that was previously occupied by the larger power supply 46. Consequently, if desired, the volume of the tank 40 can be increased.

With particular reference to FIG. 7D, the top portion 92 of the solution tank 40 comprises a first curved surface 100. The first curved surface is comprised of a curved center section 102 and substantially straight right and left lateral sections 104A, 104B. The curved center section 102 has a center of curvature 106 that is aligned with the pivot axis between the front portion 26 and rear portion 28 of the scrubber 24. The rear portion 94 of the solution tank 40 has a second curved surface 108, which also has the center of curvature 106. The radius of curvature of the center section 102 is slightly greater than the radius of curvature of the second curved surface 108. Also associated with the top portion 92 of the solution tank 94 is a circular well 110 that also has the center of curvature 106.

With reference to FIG. 3, the rear portion 28 comprises a rear frame 114 that serves as a structure to which other components of the rear portion 28 are attached. To elaborate, the rear wheels 34, vacuum squeegee 36, operator interface 38, recovery tank 42, vacuum pump 48, vertical pivot axis mechanism 50, steering interface device 52, and steering linkage 54 are each directly, indirectly or operatively attached to the rear frame 114.

The rear wheels 34 are each attached to a rear axle 116 that is operatively attached to the rear frame 114. It is feasible to attach each of the rear wheels 34 to the rear frame 114 without using an axle. However, such an approach is presently considered to be more costly and more difficult to implement.

The vacuum squeegee 36 is connected to the rear frame 114 by first and second crossing rods 118A, 118B. One end of each of the first and second crossing rods 118A, 118B is pivotally connected to the rear frame 114. The other end of each of the first and second crossing rods 118A, 118B is pivotally connected to the vacuum squeegee 36. The pivoting connections and the crossing characteristic of the rods 118A, 118B allow the vacuum squeegee 36 to swing during turns of the scrubber 24 such that the squeegee substantially follows the trail of cleaning solution and entrained debris on the floor surface left behind by the scrub head 32 during operation, thereby allowing most of the cleaning solution and entrained debris to be vacuumed up using the squeegee 36. Other mechanisms for connecting the vacuum squeegee to a scrubber that provide the noted “tracking” feature are also feasible. For instance, the structure shown in FIG. 16 of U.S. Pat. No. 5,742,975 can be employed. Other structures known to those skilled in the art, in the publicly available reference literature, or hereinafter developed are also feasible.

The operator interface 38 is connected to the rear frame 114. The operator interface 38 comprises a scrub head control interface (not identified) that allows an operator to: (a) displace the scrub head 32 towards and away from a floor surface; (b) activate and de-activate the right and/or left scrub head motors 78A, 78B; and (c) disperse cleaning solution from the solution tank 40 to a location adjacent the right and left scrubbing brushes 76A, 76B. The operator interface 38 further comprises an electric motor interface (not identified) that allows an operator to: (a) activate and de-activate the electric motor assembly 44; (b) control the electric motor assembly 44 so that the scrubber 24 can move at a desired velocity; and (c) control the electric motor assembly 44 so that the scrubber 24 moves in either a forward or reverse direction. Further comprising the operator interface 38 is a vacuum squeegee interface (not identified) that allows an operator to activate and de-activate the vacuum pump 48 that provides the vacuum power that is applied by the vacuum squeegee 36 to the floor surface to remove cleaning solution and entrained debris. As previ-
ously noted, the operator interface 38 comprises the steering interface device 52. In the illustrated embodiment, the steering interface device 52 comprises a steering wheel 120. The various interfaces are, in the illustrated embodiment, implemented in the form of hand controls. However, foot actuated controls are also feasible.

[0047] With reference to FIGS. 9A-9E and 10, the recovery tank 42 is a single tank. The recovery tank 42 could be comprised of multiple tanks. However, a multiple tank design is generally more costly to manufacture and more difficult to operate. With reference to FIG. 2C, the recovery tank 42 has an inlet cap 122 that is removed to provide access to the interior of the tank when unloading the tank in certain operations. An inlet hatch 124 is removed if access is needed to the interior of the tank 42 for cleaning and the like. The recovery tank 42 also has a drain port (not shown) that is attached to a drain hose 126 that facilitates draining the recovery tank 42.

[0048] With continuing reference to FIGS. 9A-9E and 10, the recovery tank 42 is substantially symmetrical about its longitudinal axis. Generally, this provides a substantially even lateral distribution of weight associated with any recovered cleaning solution that facilitates the steering of the scrubber 24. The recovery tank 42 is comprised of a top portion 128 and rear portion 130 that together present a generally L-shape.

[0049] With particular reference to FIG. 9D, the top port 128 of the recovery tank 42 comprises a first curved surface 132, which has the center of curvature 106 that is common to the curved surfaces associated with the solution tank 40. The rear portion 130 of the recovery tank 42 is comprised of a second curved surface 134 that, in turn, is comprised of a curved center section 136 and substantially straight right and left lateral sections 138A, 138B. The curved center section 136 has the center of curvature 106. The radius of curvature of the center section 136 is slightly greater than the radius of curvature of the first curved surface 132. Also associated with the top portion 92 of the solution tank 94 is a circular plug 140 that also has the center of curvature 106. The radius of the circular plug 140 is slightly less than the radius of the circular well 110 so that the circular plug 140 is able to nest within the circular well 110. It should be appreciated that a circular well could be associated with the recovery tank and a circular plug associated with the solution tank.

[0050] In the illustrated embodiment, the steering interface device 52 is a steering wheel 142. It should be appreciated that any steering interface device known or yet to be developed that is capable of providing a steering direction is feasible. For example, a joy-stick that provides either mechanical or electrical directional signals is feasible. A push button interface that provides electrical directional signals is also feasible.

[0051] In the illustrated embodiment, the steering linkage 54 is a mechanical linkage. However, any linkage known or yet to be developed that is capable of translating or conveying the directional signals produced by the steering interface device 52 so as to achieve the desired rotation between the front portion 26 and the rear portion 28 of the scrubber 24 is feasible. For example, mechanical steering linkages comprised of gears, rods, hydraulic components, or pneumatic components, and combinations thereof are feasible. Also feasible are electrical steering linkages that use electrical motors, solenoids, or the like, and combinations thereof. Also feasible are steering linkages that use combinations of electrical and mechanical components.

[0052] In the illustrated embodiment, the steering linkage 54 is comprised of steering wheel axle assembly 144, sprocket 146, chain 148, cable 150, upper pulley pair 152A, 152B, and lower pulley pair 154A, 154B. The steering wheel axle assembly 144 is comprised of a pair of bearings 156A, 156B that are attached to the rear frame 114 and support a steering axle 158. The steering wheel 142 is attached to one end of the steering axle 158. Attached to the portion of the steering axle 158 between the bearings 156A, 156B is the sprocket 146. The chain 148 engages the sprocket 146. The ends of the chain 148 are attached to the cable 150. The cable 150 passes around the upper pulley pair 152A, 152B and the lower pulley pair 154A, 154B. Each of the pulleys is attached to the rear frame 114 in a manner that allows rotation of the pulley. One of the lower pulley pair 154A, 154B is positioned slightly higher than the other pulley to allow the cable to readily cross over itself before engaging the vertical pivot axis mechanism 50.

[0053] The vertical axis pivot mechanism 50 is comprised of a vertical axle 160 (which defines the pivot axis between the front portion 26 and rear portion 28) that is supported by a pair of bearings 162A, 162B that are connected to the front frame 62 and rear frame 114. The vertical axle 160 and bearings 162A, 162B cooperate to allow pivoting movement between the front portion 26 and the rear portion 28. The mechanism 50 further comprises a plate 164, which can be grooved or ungrooved, which is fixed to the front frame 62. With reference to FIG. 12, the cable 150 is attached to the plate 164 using a serpentine channel 166 in the plate 164 that forces the cable 150 to go through several bends that, in turn, prevent the cable 150 from slipping. Other structures for attaching the cable 150 to the plate 164 are known to those skilled in the art or present in the relevant literature are feasible.

[0054] In operation, rotation of the steering wheel 142 causes a corresponding rotation of the plate 164. Due to the attachment of the plate 164 to the front frame 62, the front frame 62 is rotated relative to the rear frame 114. More generally, the front portion 26 is rotated relative to the rear portion 28, as exemplified in FIGS. 4, 5 and 6.

[0055] In the illustrated embodiment, the steering wheel 142 rotates about an axis that is substantially horizontal, i.e., within +/-15 degrees of horizontal.

[0056] It should be appreciated that many different types of steering linkages are feasible. The illustrated linkage is relatively low cost and considered to be highly reliable due to the low number of parts. However, many other types of steering linkages are feasible, comprising but not limited to substantially entirely mechanical linkages, substantially entirely electrical linkages, and combinations of mechanical and electrical linkages. In this regard linkages that employ one or more rods, one or more cables, one or more gears, one or more axles, one or more bearings, one or more chains, one or more electrical motors, or one or more solenoids, and combinations thereof are feasible. Characteristic of any steering linkage suitable for use in the scrubber is that it is capable of providing a force that has a component that is normal to a radius having a center at the vertical axle 160 or
the center of curvature 106, which is aligned with the vertical axle 160, and of sufficient magnitude to rotate the front portion 26 relative to the rear portion 28 and thereby turn the scrubber 24.

[0057] FIG. 3 illustrates the relationship between the solution tank 40 and the recovery tank 42. To elaborate, portions of the recovery tank 42 are located above portions of the solution tank 40. Further, portions of the recovery tank 42 are located above and to the side of the solution tank 40. Specifically, the top portion 128 of recovery tank 42 is located above the rear portion 94 and portions of the right and left side portions 96A, 96B of the solution tank 40. The rear portion 130 of the recovery tank is located to the side of the solution tank 40. Further, portions of the solution tank 40 are located below and to the side of the recovery tank 42. Specifically, the rear portion 94 and portions of the right and left side portion 96A, 96B are located below the top portion 128 of the recovery tank 42. The top portion 92 of the solution tank 40 is located to the side of the recovery tank 42. The pivot axis between the front portion 26 and the rear portion 28, which is defined by the pivot axle 160, extends through the overlapping portions of the solution tank 40 and recovery tank 42. The center of curvature 106 for the curved surfaces associated with the solution tank 40 and recovery tank 42 is a point that is substantially located on the pivot axis. It should be appreciated that modifications are possible that would associate a recovery tank with the front portion of the scrubber and a solution tank with the rear portion of the scrubber. Further, solution and recovery tanks of different shapes are also feasible.

[0058] With reference to FIGS. 13 and 14, the solution tank 40 and recovery tank 42 are shown in the situation when the scrubber 24 is in a hard right turn. With respect to FIG. 13, the right lateral section 104A of the first curved surface 100 of the top portion 92 of the solution tank 40 is substantially parallel to the straight side surface of the top portion 128 of the recovery tank 42 at the point of the maximum possible right turn. With respect to FIG. 14, the right lateral section 138A of the second curved surface 134 of the rear portion 130 of the recovery tank 42 is substantially parallel to the straight side surface of the rear portion 94 of the solution tank 40 at the point of the maximum possible right turn. A comparable situation occurs for the maximum possible left turn. In the illustrated embodiment, the maximum possible right and left turns occur when portions of the front frame 62 and the rear frame 114 come into contact with one another. To prevent damage to the solution tank 40 and the recovery tank 42, the portions of the front frame 62 and the rear frame 114 come into contact with one another before the solution tank 40 and recovery tank 42 contact one another.

[0059] With reference to FIG. 15, a second embodiment of a scrubber 170 is illustrated. The scrubber 170 comprises a rear-mounted platform 172 that allows an operator to stand on the scrubber 170 rather than walk behind the scrubber. The platform 172 can be either a permanent fixture or a detachable fixture of the scrubber 172. The platform 172 facilitates, relative to the walk-behind embodiment, the implementation of one or more foot-actuated controls as part of the operator interface 38. In other respects, the scrubber 170 is substantially identical to the scrubber 24.

[0060] With reference to FIG. 16, a second embodiment of a scrubber 174 is illustrated. The scrubber 170 comprises a rear-mounted seat 176 that allows an operator to sit on the scrubber 170 rather than walk behind the scrubber. The seat 176 can be either a permanent fixture or a detachable fixture of the scrubber 172. The seat 176 facilitates, relative to the walk-behind embodiment, the implementation of one or more foot-actuated controls as part of the operator interface 38. In other respects, the scrubber 170 is substantially identical to the scrubber 24.

[0061] With reference to FIG. 3, the dimensions of a scrubber 24 are a wheel base of about 24 inches, an overall length of about 74 inches, a horizontal distance from the steering wheel 142 to the vertical axle 160 of about 29 inches, a horizontal distance from the vertical axle 160 to the rear axle 116 of about 9 inches, a distance from the vertical axle 160 to the drive axle 70 of about 16 inches, a width of about 28 inches (not including the scrub head 32 or vacuum squeegee 36), and a maximum height of about 45 inches, thus providing the operator with a good view of the floor to the front of scrubber 20. Modification of one or more these dimensions for a particular application is feasible.

1. An articulated floor scrubber comprising:
   a front portion comprising a first pair of wheels and a scrub head;
   a rear portion comprising a second pair of wheels and a vacuum squeegee;
   a pivot mechanism for pivotally connecting said front portion and said rear portion, wherein said pivot mechanism has a vertical pivot axis;
   a solution tank for holding a cleaning fluid and providing cleaning fluid for application to a floor;
   a recovery tank for holding cleaning fluid and debris that is received from said vacuum squeegee;
   a steering system that allows an operator to cause relative rotational movement between said front portion and said rear portion;
   a motor system for driving one of said first and second pairs of wheels;
   wherein said solution tank is associated with one of said front portion and said rear portion, and said recovery tank is associated with the other of said front portion and said rear portion; and
   said vertical pivot axis passes through both of said solution tank and said recovery tank.

2. An articulated floor scrubber, as claimed in claim 1, wherein:
   said solution tank comprises a first solution tank portion and a second solution tank portion;
   said recovery tank comprises a first recovery tank portion and a second recovery tank portion;
   wherein said first solution tank portion and said first recovery tank portion overlap.

3. An articulated floor scrubber, as claimed in claim 2, wherein:
   said second solution tank portion and said second recovery tank portion do not overlap.

4. An articulated floor scrubber, as claimed in claim 2, wherein:
said vertical pivot axis extends through said first solution tank portion and said first recovery tank portion.

5. An articulated floor scrubber, as claimed in claim 2, wherein:

said solution tank comprises a curved surface with a center of curvature that is coincident with said vertical pivot axis.

6. An articulated floor scrubber, as claimed in claim 2, wherein:

said recovery tank comprises a curved surface with a center of curvature that is coincident with said vertical pivot axis.

7. An articulated floor scrubber, as claimed in claim 2, wherein:

said solution tank comprises a first curved surface and a second curved surface that is separated from said first curved surface;

wherein said first and second curved surfaces each have a center of curvature that is coincident with said vertical pivot axis.

8. An articulated floor scrubber, as claimed in claim 2, wherein:

said recovery tank comprises a first curved surface and a second curved surface that is separated from said first curved surface;

wherein said first and second curved surfaces each have a center of curvature that is coincident with said vertical pivot axis.

9. An articulated floor scrubber, as claimed in claim 1, wherein:

said steering system comprises a steering interface device that is associated with said rear portion.

10. An articulated floor scrubber, as claimed in claim 1, wherein:

said steering system comprises a steering wheel and a steering wheel axle that lies within a substantially horizontal plane.

11. An articulated floor scrubber, as claimed in claim 1, wherein:

said steering system comprises a steering linkage that does not comprise a dual groove pulley.

12. An articulated floor scrubber, as claimed in claim 1, wherein:

said motor system comprises an electric motor and a power supply.

13. An articulated floor scrubber, as claimed in claim 12, wherein:

said electric motor is associated with said front portion.

14. An articulated floor scrubber, as claimed in claim 12, wherein:

said power supply is associated with said front portion.

15. An articulated floor scrubber, as claimed in claim 12, wherein:

said electric motor is associated with said front portion; and

said power supply is associated with said front portion.

16. An articulated floor scrubber, as claimed in claim 1, wherein:

said solution tank has a first curved surface with a first center of curvature;

said recovery tank has second curved surface with a second center of curvature;

wherein said first and second centers of curvature are coincident with said vertical pivot axis.

17. An articulated floor scrubber, as claimed in claim 1, wherein:

said solution tank has a first and second curved surfaces, each with a first center of curvature;

said recovery tank has third and fourth curved surfaces, each with a second center of curvature;

wherein said first and second centers of curvature are coincident with said vertical pivot axis.

18. An articulated floor scrubber comprising:

a front portion comprising a first pair of wheels and a scrub head;

a rear portion comprising a second pair of wheels and a vacuum squeegee;

a pivot mechanism for pivotally connecting said front portion and said rear portion, wherein said pivot mechanism has a vertical pivot axis;

a solution tank for holding a cleaning fluid and providing cleaning fluid for application to a floor;

a recovery tank for holding cleaning fluid and debris that is received from said vacuum squeegee;

a steering system that allows an operator to cause relative rotational movement between said front portion and said rear portion;

a motor system for driving one of said first and second pairs of wheels;

wherein said solution tank is associated with one of said front portion and said rear portion, and said recovery tank is associated with the other of said front portion and said rear portion;

wherein said solution tank has a first curved surface with a first center of curvature;

wherein said recovery tank has second curved surface with a second center of curvature;

wherein said first and second centers of curvature are coincident with said vertical pivot axis.

19. An articulated floor scrubber, as claimed in claim 18, wherein:

said vertical pivot axis passes through one of said solution tank and said recovery tank.

20. An articulated floor scrubber, as claimed in claim 18, wherein:

said vertical pivot axis passes through both of said solution tank and said recovery tank.