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(54) **HARD AND SOFT FLOOR SURFACE CLEANER**

(75) Inventors: **David Alan Nelson**, Grand Rapids, MI (US); **Larry James Juliot**, Champlin, MN (US); **Larry D. Wydra**, Plymouth, MN (US); **Daniel John Feyma**, Crystal, MN (US); **Dan Sidney Albrecht**, Buffalo, MN (US)

Correspondence Address:
WESTMAN CHAMPLIN & KELLY, P.A.
SUITE 1400
900 SECOND AVENUE SOUTH
MINNEAPOLIS, MN 55402-3319 (US)

(73) Assignee: **Tennant Company**, Minneapolis, MN

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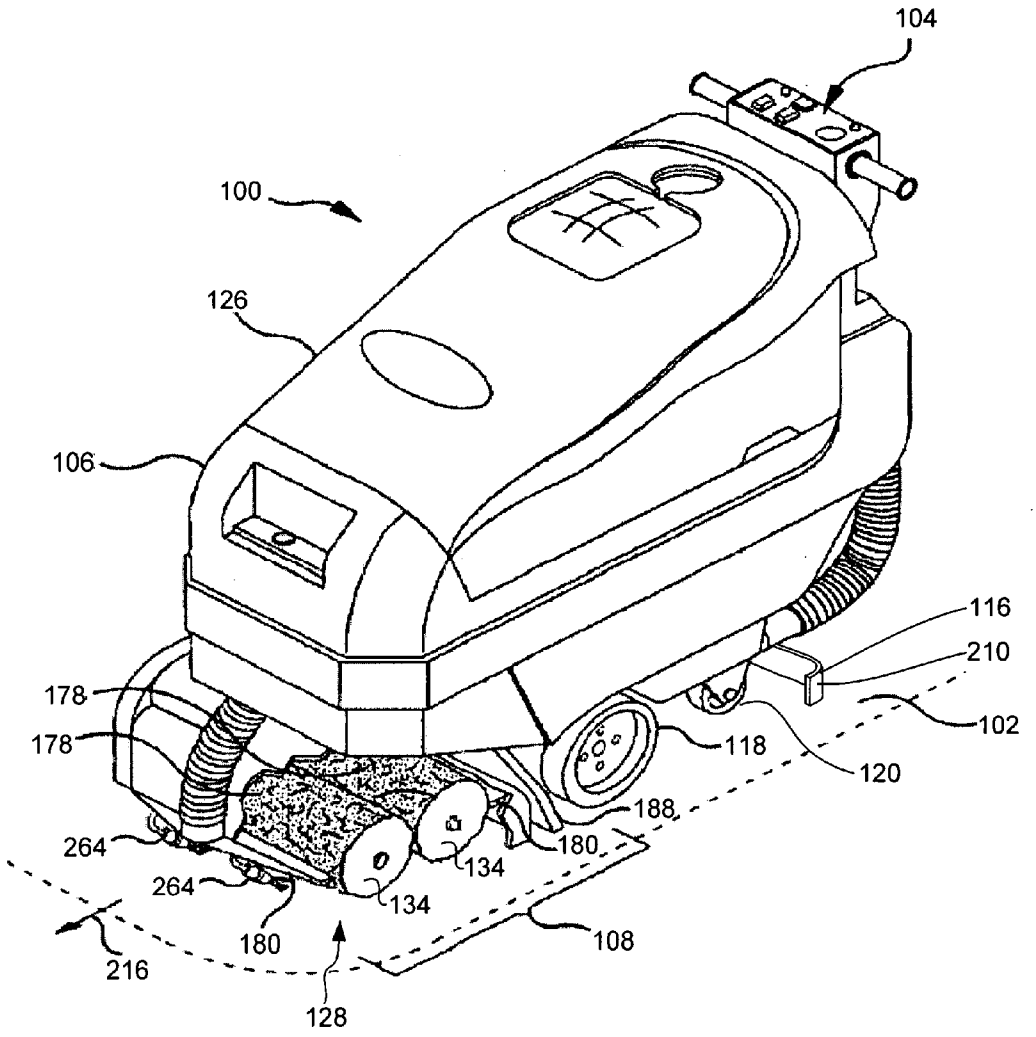
(52) **U.S. Cl.** **15/320**

(57) **ABSTRACT**

A floor cleaner configured to perform both hard and soft floor cleaning operations includes a mobile body, a motorized cleaning head, a cleaning liquid dispenser, a vacuum, a first vacuum extractor tool and a vacuum squeegee connected to the mobile body. The mobile body is configured to travel over a surface. The motorized cleaning head is connected to the mobile body and includes a cleaning tool. The cleaning liquid dispenser is configured to apply a cleaning liquid to the surface or the cleaning tool. The first vacuum extractor tool is configured for vacuum communication with the vacuum through a first vacuum path.



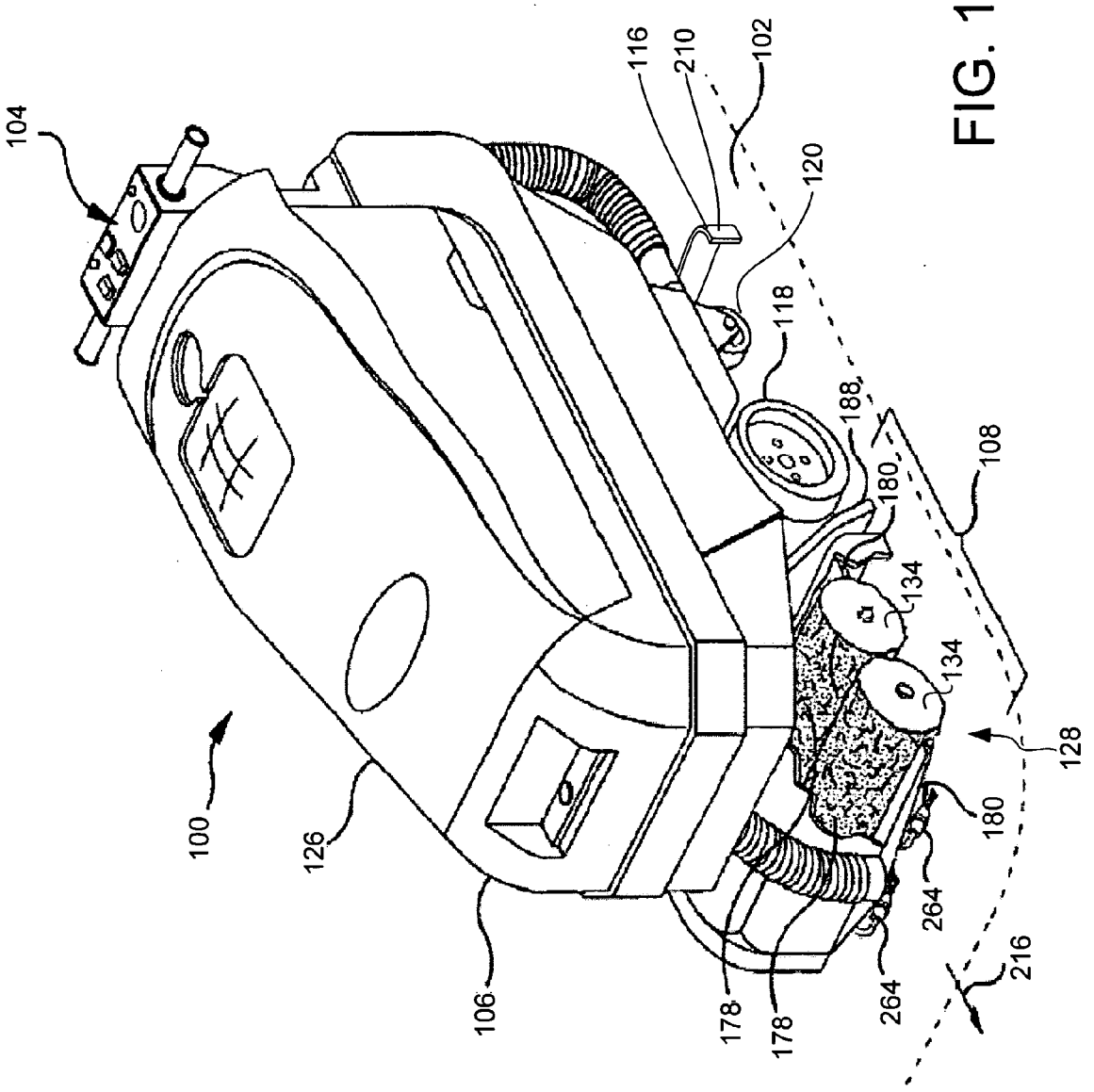
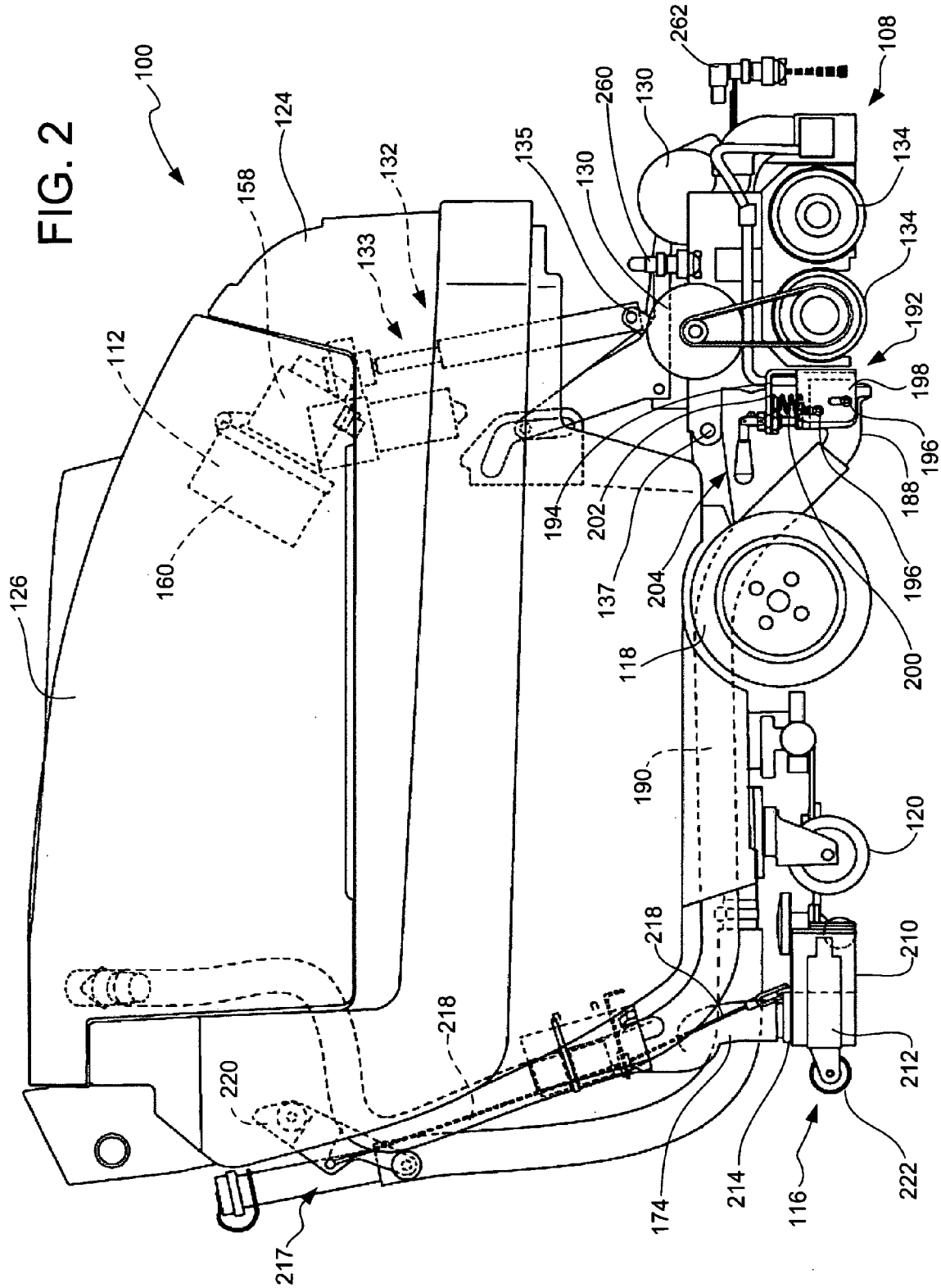

104
116
210
102
120
118
188
180
108
134
134
128
180
264
216
264
178
178
106
126
100

FIG. 1

FIG. 2


100
158
124
132
135
130
260
130
262
108
134
134
133
112
192
198
196
188
194
202
137
204
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200
118
190
120
218
210
218
212
220
214
116
222
174
217

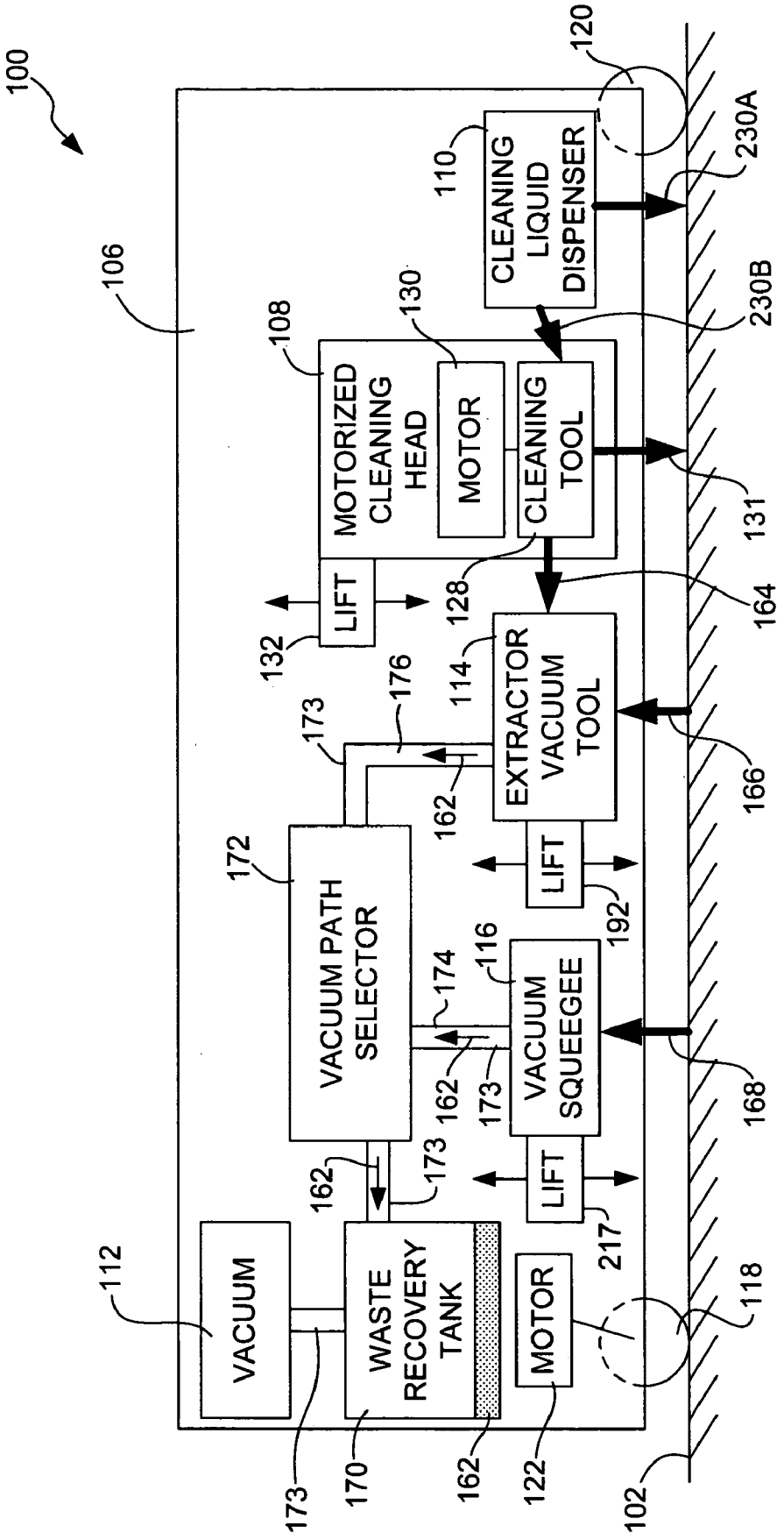
100
106
108
MOTORIZED CLEANING HEAD
130
MOTOR
CLEANING TOOL
131
110
CLEANING LIQUID DISPENSER
120
230A
230B
LIFT
132
128
164
114
EXTRACTOR VACUUM TOOL
166
176
173
162
172
VACUUM PATH SELECTOR
LIFT
192
116
VACUUM SQUEEGEE
174
168
LIFT
217
112
VACUUM
WASTE RECOVERY TANK
MOTOR
118
170
122
102

FIG. 3

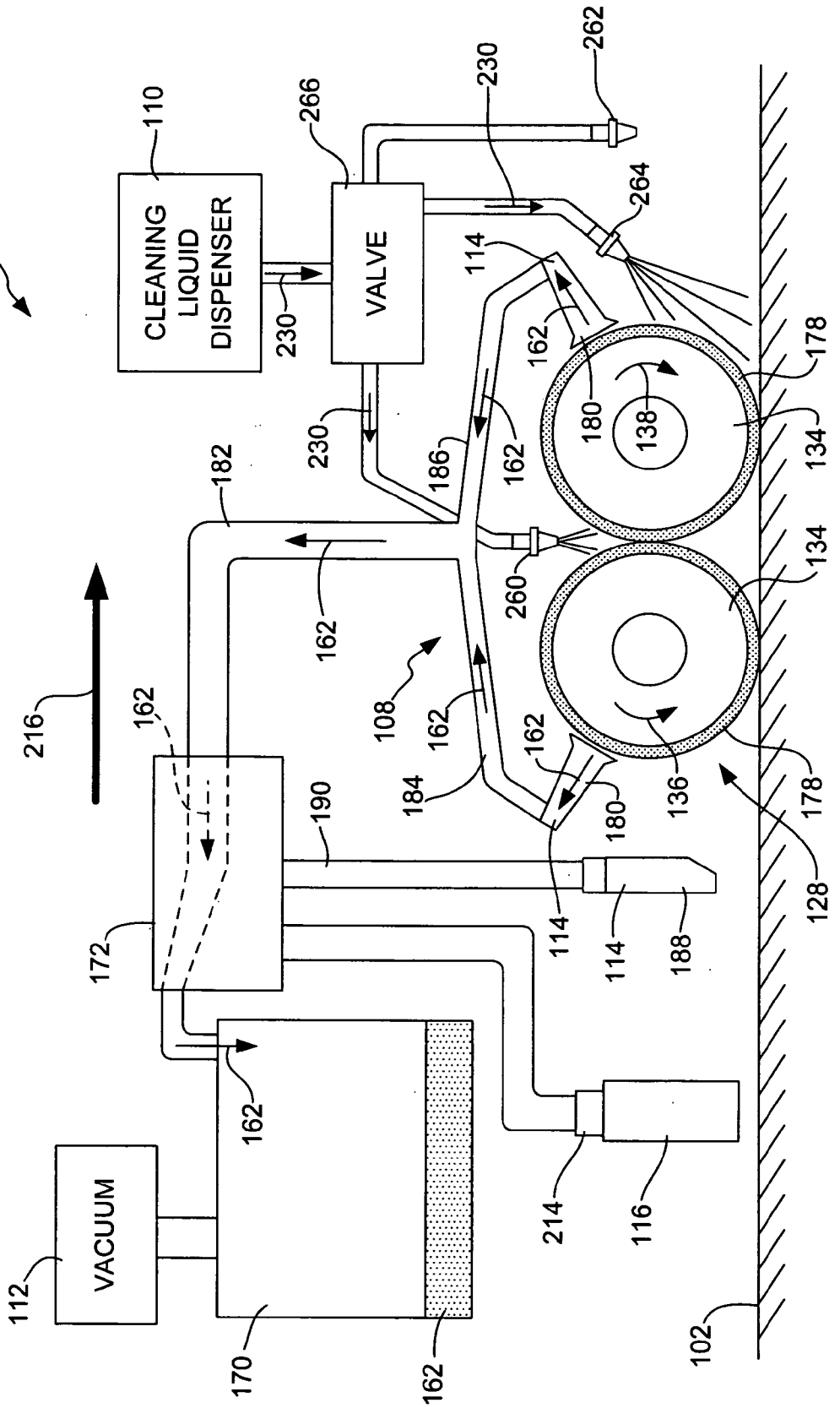
100
110
CLEANING LIQUID DISPENSER
266
VALVE
230
262
264
114
162
178
180
138
134
230
186
182
260
216
108
184
190
136
128
172
188
112
VACUUM
170
214
116
102

FIG. 4

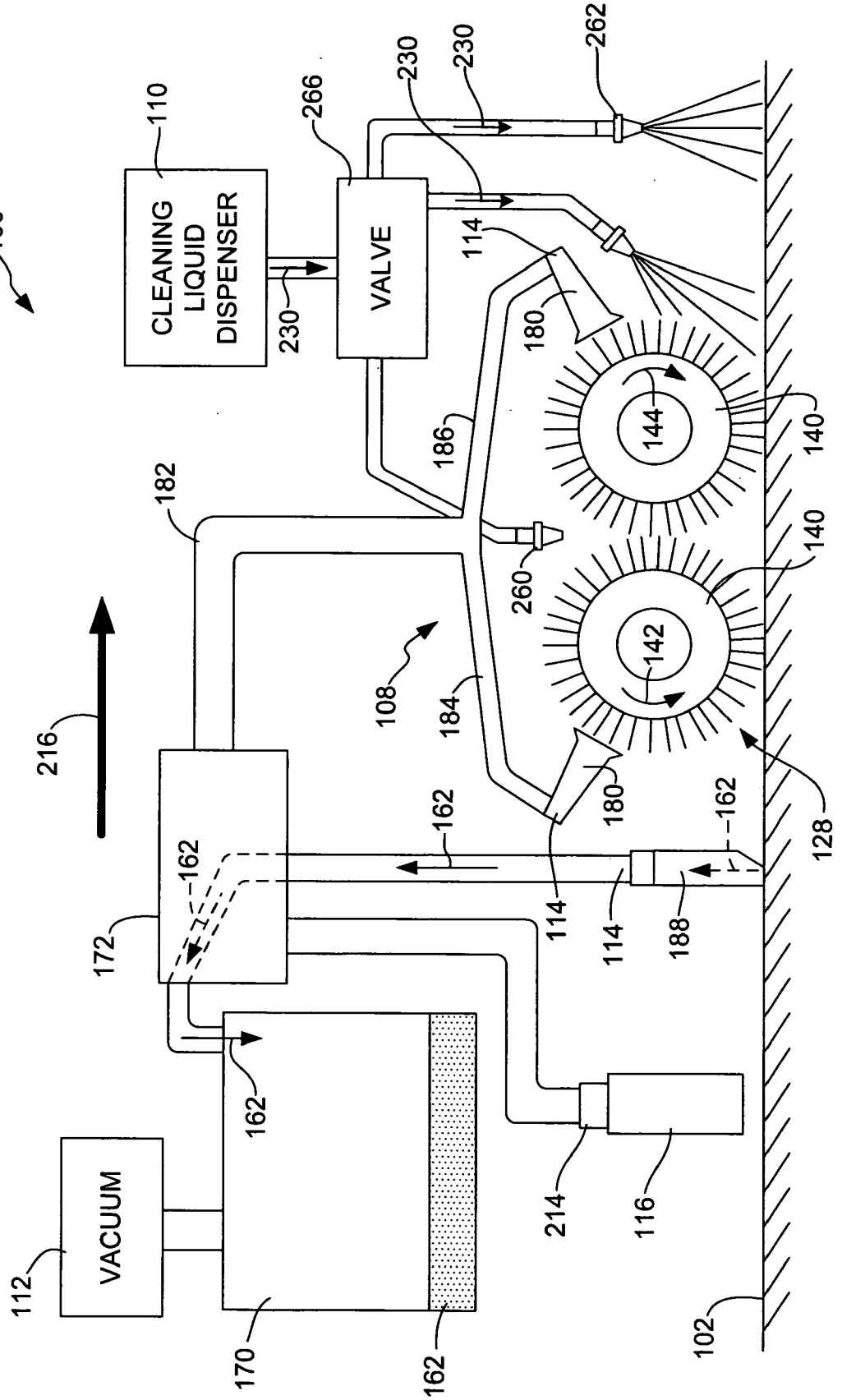
100
110
CLEANING LIQUID DISPENSER
VALVE
266
230
230
262
230
114
180
186
182
144
140
140
260
142
108
184
216
180
162
162
162
128
172
114
114
188
162
214
116
VACUUM
112
170
162
102

FIG. 5

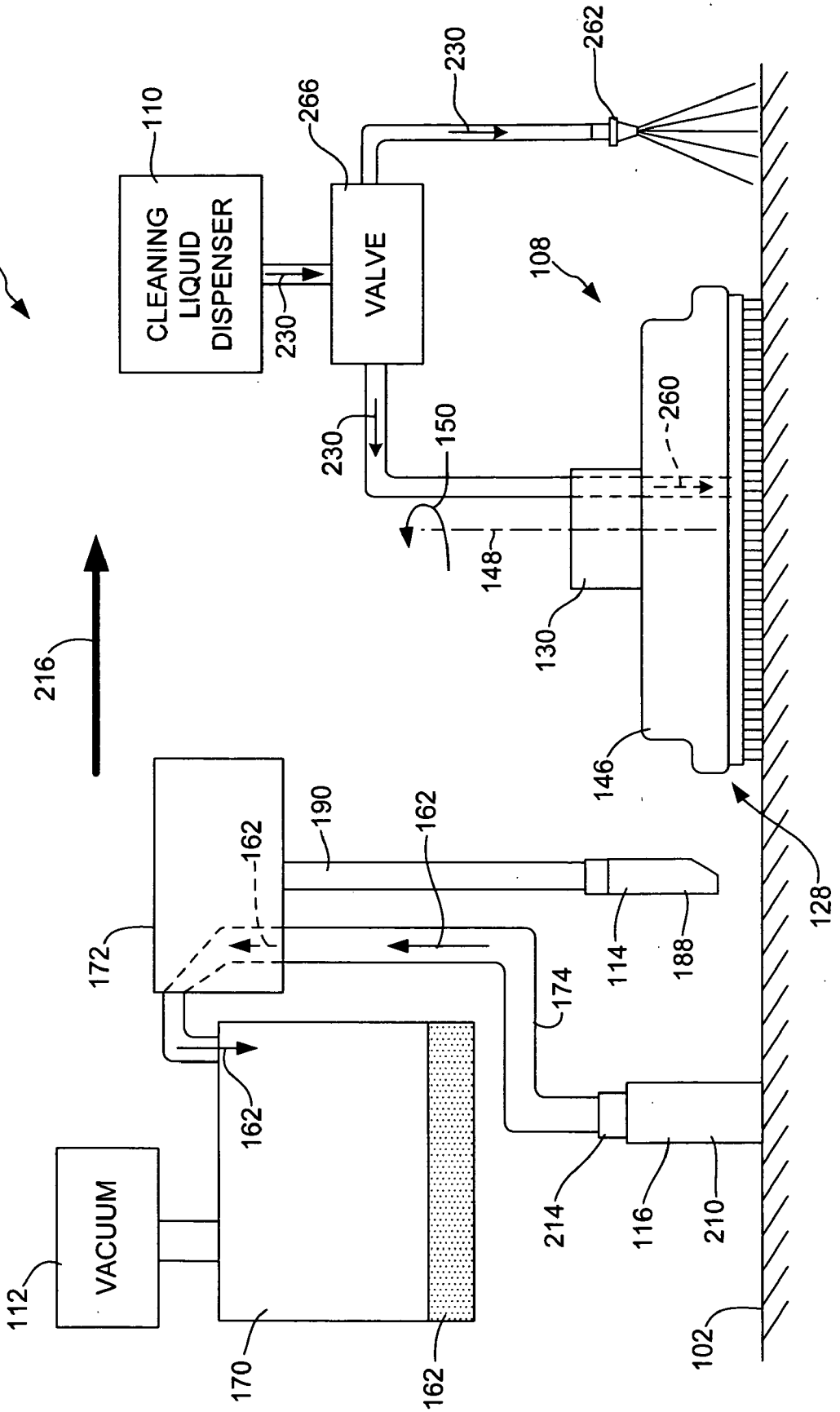
100
110
CLEANING LIQUID DISPENSER
266
VALVE
230
262
230
230
108
260
150
148
130
216
146
128
162
190
162
172
114
188
174
162
214
116
210
112
VACUUM
170
162
102

FIG. 6

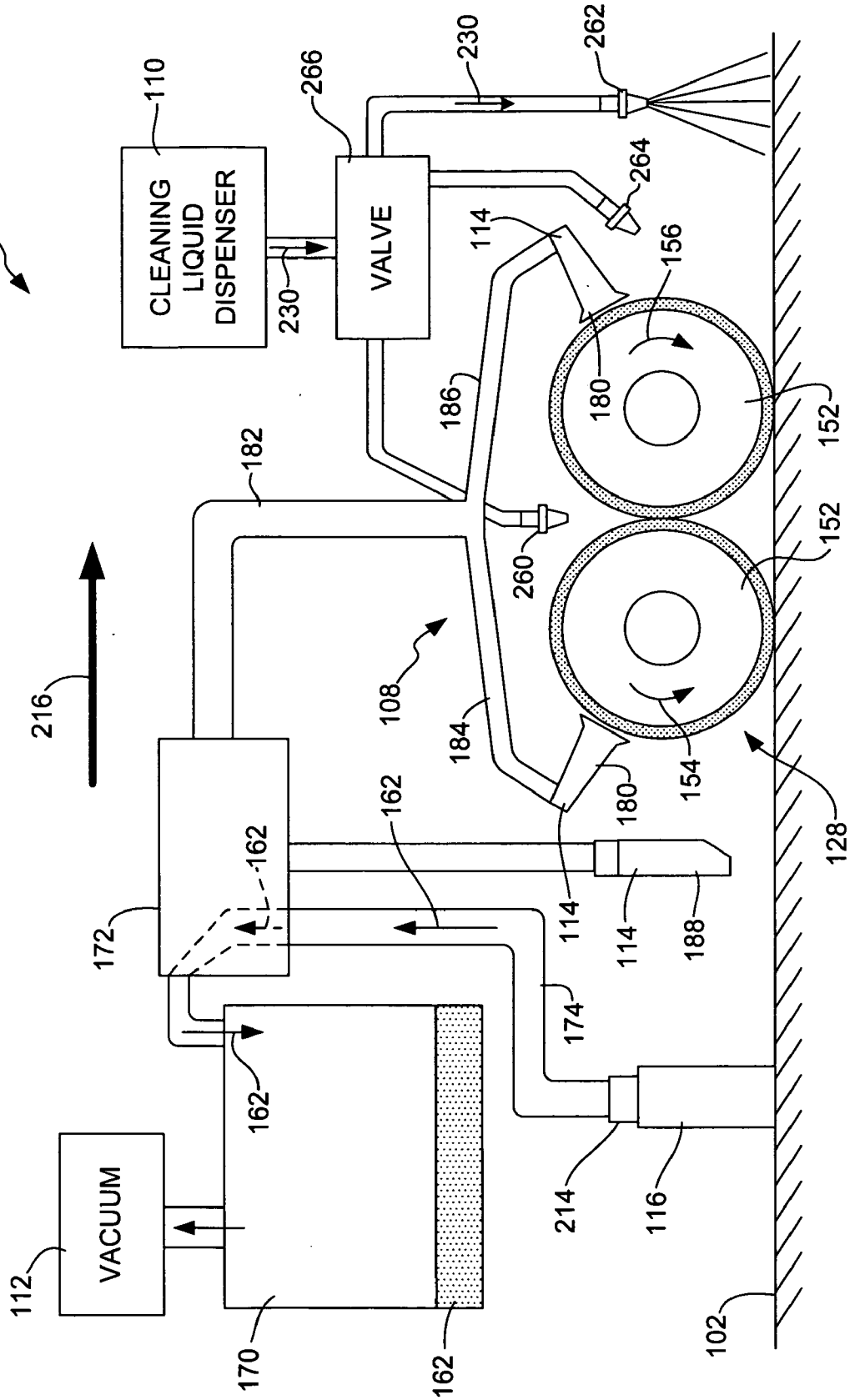
100
110
CLEANING LIQUID DISPENSER
266
VALVE
230
230
262
264
114
156
180
186
152
182
260
152
216
108
184
154
180
128
162
162
172
114
114
188
174
162
214
116
112
VACUUM
170
162
102

FIG. 7

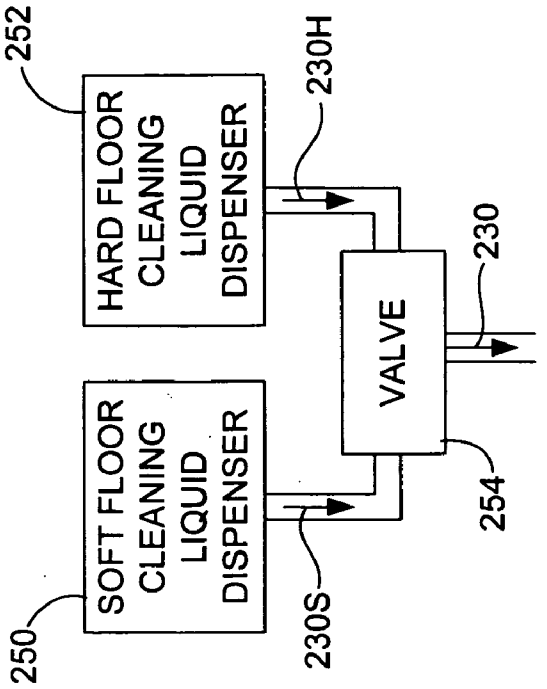
252
HARD FLOOR CLEANING LIQUID DISPENSER
230H
230
VALVE
254
SOFT FLOOR CLEANING LIQUID DISPENSER
250
230S

FIG. 9

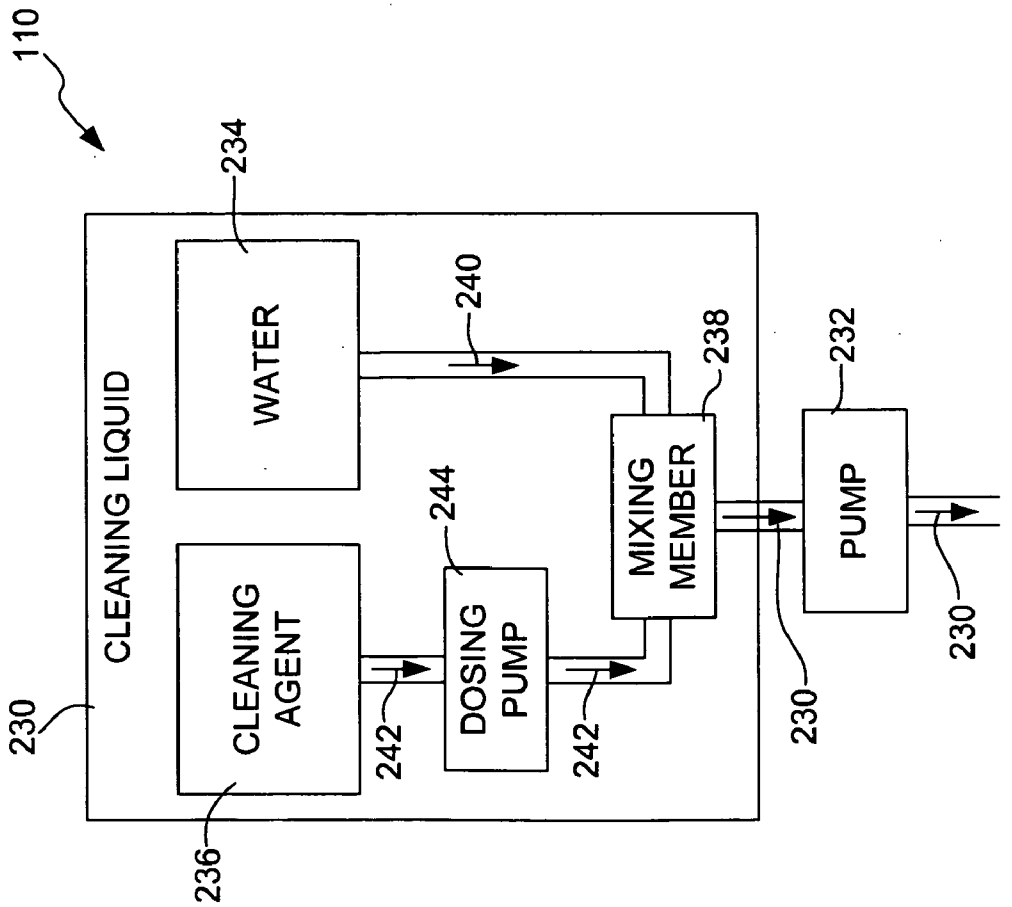
110
234
CLEANING LIQUID
WATER
240
238
232
MIXING MEMBER
PUMP
244
CLEANING AGENT
DOSING PUMP
242
242
230
230
230
236

FIG. 8

HARD AND SOFT FLOOR SURFACE CLEANER

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application is based on and claims the benefit of U.S. provisional patent application Ser. No. 60/669,054, filed Apr. 7, 2005, the content of which is hereby incorporated by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention generally relates to a floor cleaning machine and, more particularly, to a floor cleaning machine that is configurable to perform both hard and soft floor cleaning operations.

BACKGROUND OF THE INVENTION

[0003] Mobile floor cleaners, such as those produced by Tennant Company of Minneapolis, Minnesota, are generally designated as either a soft floor cleaner configured to perform a cleaning operation on a soft floor (e.g., carpet, rugs, etc.), or a hard floor cleaner configured to perform a cleaning operation on a hard floor surface (e.g., tile, linoleum, cement, etc.).

[0004] Soft floor cleaning operations include soil transfer and deep extraction cleaning operations. U.S. Pat. No. 6,735,812, which is assigned to Tennant Company, describes a dual mode cleaner that is configurable to perform both soil transfer and deep cleaning extraction operations on a carpeted surface.

[0005] Soil transfer cleaning operations utilize special cylindrical rollers to which a cleaning solution is applied with pumps and spray heads. When the rollers are rotated against a surface, soil is transferred to the rollers and the soil cleaning liquid is subsequently suctioned from the rollers with vacuum extractor tools. This technology can be used to clean various fabric surfaces. The roller design, rotational speed, pressure, vacuum parameters and cleaning liquid flows can be altered in the same machine to optimize cleaning for the particular carpet or fabric. The cleaning liquid can be minimized to reduce drying time while still providing effective interim cleaning of carpet, thereby allowing a space to be ready for use in less than one hour.

[0006] Deep cleaning extraction cleaning operations are typically performed less frequently than the soil transfer cleaning operation. The deep cleaning extraction operation generally performs a more thorough cleaning of a carpeted surface. During such a cleaning operation, a relatively large amount of cleaning solution is sprayed directly onto the carpeted or soft floor surface. The carpet is scrubbed with brushes designed for the surface and soiled liquid is extracted from the carpet with one or more vacuum extractor tools located behind the brushes. Carpets cleaned with the deep cleaning extraction operation require considerably longer drying times before use than carpets cleaned with the soil transfer method.

[0007] Hard floor surface cleaning operations are performed by hard floor surface cleaners that generally employ scrubbing brushes and a vacuumized fluid recovery system positioned behind the scrubbing brushes. A cleaning liquid is typically sprayed directly to the floor and/or on the brushes and the hard floor surface is scrubbed with the brushes. The vacuumized fluid recovery system typically includes a vacuum squeegee that collects the soiled cleaning liquid and delivers the soiled cleaning liquid to a recovery tank. The vacuum squeegee removes substantially all of the liquid waste left by the scrubbing brushes from the hard floor surface, leaving the surface ready for use almost immediately.

[0008] Cleaning operations on spaces having a mixture of soft floor surfaces and hard floor surfaces have generally required separate soft and hard floor cleaning machines. Such a requirement is costly in terms of the time required to complete the multi-surface cleaning operations and the maintenance and storage of multiple machines.

SUMMARY OF THE INVENTION

[0009] The present invention generally relates to a floor cleaner configured to perform both hard and soft floor cleaning operations. The cleaner generally includes a mobile body, a motorized cleaning head, a cleaning liquid dispenser, a vacuum, a first vacuum extractor tool and a vacuum squeegee connected to the mobile body. The mobile body is configured to travel over a surface. The motorized cleaning head is connected to the mobile body and includes a cleaning tool. The cleaning liquid dispenser is configured to apply a cleaning liquid to the surface or the cleaning tool. The first vacuum extractor tool is configured for vacuum communication with the vacuum through a first vacuum path.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] **FIG. 1** is a perspective view of a floor cleaner **100** in accordance with embodiments of the invention.

[0011] **FIG. 2** is a side view of a floor cleaner **100** in accordance with embodiments of the invention.

[0012] **FIG. 3** is a block diagram of a floor cleaner in accordance with embodiments of the invention.

[0013] **FIG. 4** is a simplified block diagram of embodiments of the cleaner in soil transfer mode of operation with the mobile body and other components removed.

[0014] **FIG. 5** is a simplified block diagram of embodiments of the cleaner in deep extraction cleaning mode of operation with the mobile body and other components removed.

[0015] **FIG. 6** is a simplified block diagram of embodiments of the cleaner in hard floor scrubbing mode of operation with the mobile body and other components removed.

[0016] **FIG. 7** is a simplified block diagram of embodiments of the cleaner in hard floor scrubbing mode of operation with the mobile body and other components removed.

[0017] **FIG. 8** is a block diagram of a cleaning liquid dispenser in accordance with embodiments of the invention.

[0018] **FIG. 9** is a block diagram of a soft and hard floor cleaning liquid dispensers in accordance with embodiments of the invention.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

[0019] The present invention relates to a floor cleaner **100** that is configurable for performing both hard floor cleaning

operations and soft floor cleaning operations. **FIGS. 1-3** respectively show a perspective view of the floor cleaner, a side view of the cleaner and a block diagram of the floor cleaner, in accordance with embodiments of the invention.

[0020] As will be discussed below in greater detail, embodiments of the cleaner **100** include a soil transfer cleaning mode in which the cleaner **100** is configured to perform a soil transfer cleaning operation on a floor surface **102** (i.e., a soft floor surface) and/or an deep extraction mode, in which the cleaner **100** is configured to perform a deep extraction cleaning operation on the surface **102**. Additionally, one embodiment of the cleaner **100** includes a hard floor scrubbing mode, in which the cleaner **100** is configured to scrub the floor surface **102** (i.e., a hard floor surface **102**) and remove liquid waste and debris with a fluid recovery system.

[0021] The floor cleaner **100** shown in **FIGS. 1 and 2** is configured for use by an operator that walks behind the cleaner **100**. A control panel **104** provides various settings for controlling the operation of the cleaner **100**. Alternatively, the cleaner **100** may be designed as a ride-on cleaner, or towed-behind cleaner. The cleaner **100** may be powered through an on-board power source, such as batteries or an internal combustion engine, or powered though an electrical cord.

[0022] Embodiments of the floor cleaner **100** generally include a mobile body **106**, a motorized cleaning head **108**, a cleaning liquid dispenser **110**, one or more vacuums **112**, at least one vacuum extractor tool **114** and a vacuum squeegee **116**.

[0023] One embodiment of the mobile body **106** comprises framework for supporting the various components of the cleaner **100**. The mobile body **106** supported on drive wheels **118** and castor wheels **120** for travel over the surface **102**. In one embodiment, the drive wheels are driven by a motor **122**. A housing **124** encloses many of the components of the cleaner **100** that are supported on the mobile body **106**. Some of the components (e.g., batteries, tanks, etc.) can be accessed by opening a cover **126**.

[0024] The motorized cleaning head **108** is connected to the mobile body **106**. In one embodiment the motorized head is positioned at a forward location of the cleaner **100**, as shown in **FIGS. 1 and 2**. However, the cleaning head **108** can also be positioned at other locations relative to the mobile body **106**, such as central and rearward locations of the cleaner **100**.

[0025] The cleaning head **108** includes a cleaning tool **128** and one or more motors **130** for driving rotation of the cleaning tool **128** about an axis that is either parallel or perpendicular to the surface **102**. The rotating cleaning tool **128** engages the surface **102** to perform a hard or soft floor cleaning operation, as indicated by arrow **131** in **FIG. 3**.

[0026] In accordance with one embodiment of the cleaner **100** includes a cleaning head lift **132** configured to lower the cleaning head **108** for floor cleaning operations and raise the cleaning head **108** when not in use, such as during transport of the cleaner **100**. One embodiment of the head lift **132**, shown in **FIG. 2**, includes a motorized screw drive **133** coupled to the head through a suitable linkage **135**, which pivots the head **108** about a connection **137** to raise or lower the head **108** as desired.

[0027] One embodiment of the cleaning head **108** is configured for use with multiple types of cleaning tools **128** in order to accommodate different cleaning operations while using the same motors **130**, for example. Thus, the cleaning head **108** can be equipped with a soft floor cleaning tool **128** to allow the cleaner to perform a soft floor cleaning operation. The soft floor cleaning tool **128** can then be replaced with a hard floor cleaning tool **128** to allow the cleaner **100** to perform a hard floor cleaning operation. Alternatively, the cleaner **100** is configurable with separate soft and hard floor cleaning heads **108** respectively including soft and hard floor cleaning tools **128**.

[0028] As mentioned above, embodiments of the cleaner **100** include several different modes of operation including a soil transfer soft floor cleaning mode, a deep extraction soft floor cleaning mode, and at least two hard floor scrubbing modes. **FIG. 4** is a block diagram of embodiments of the cleaner **100** in soil transfer mode of operation with the mobile body **106** and other components removed to simplify the illustration. In this embodiment, the cleaning tool **128** includes one or more soil transfer rolls **134**, shown in **FIGS. 1, 2** and **4**, that are driven by one or more motors **130** to respectively rotate the rolls **134** about their horizontal axes in the directions indicated by arrows **136** and **138**, shown in **FIG. 4**, during soil transfer cleaning operations on the soft floor surface **102**.

[0029] **FIG. 5** is a simplified block diagram of embodiments of the cleaner **100** in a deep extraction soft floor cleaning mode of operation with the mobile body **106** and other components removed. In this embodiment, the cleaning tool **128** includes one or more deep extraction brushes **140** that are dedicated for use in a deep extraction soft floor cleaning operation. Exemplary deep extraction brushes **140** are shown in **FIG. 5**, which and are respectively driven by one or more motors **130** for rotation about their horizontal axes in the directions indicated by arrows **142** and **144** during deep extraction cleaning operations on the soft floor surface **102**.

[0030] **FIG. 6** is a simplified block diagram of embodiments of the cleaner **100** in hard floor scrubbing mode of operation with the mobile body **106** and other components removed. In accordance with this embodiment, the cleaning tool **128** includes one ore more hard floor scrub brushes **146** dedicated to performing a hard floor cleaning operation. An exemplary hard floor scrub brush **146** is shown in **FIG. 6**, that is configured to rotate about a vertical axis **148** as indicated by arrow **150**, during a scrubbing operation on hard floor surface **102**. In one embodiment, at least one other scrub brush is positioned adjacent the depicted scrub brush **146** to expand the width of the scrubbing swath covered by the cleaning head **108**.

[0031] **FIG. 7** is a simplified block diagram of embodiments of the cleaner **100** in a second hard floor scrubbing mode of operation, in which the cleaning tool **128** includes "hybrid" rolls **152** configured to perform soil transfer soft floor cleaning operations and hard floor scrubbing operations respectively on soft and hard floor surfaces **102**. In one embodiment, the hybrid rolls **152** are driven by one or more motors **130** for rotation about their horizontal axes in the directions indicated by arrows **154** and **156**, during the cleaning operations.

[0032] The one or more vacuums **112** each generally include a motor **158** and vacuum fan **160** (**FIG. 2**). The

vacuum fan(s) **112** is used in combination with the at least one vacuum extractor tool **114** to remove liquid and solid waste **162** (i.e., soiled cleaning liquid) from the cleaning tool **128** of the cleaning head **108** and/or the surface **102**, as respectively indicated by arrows **164** and **166**. One vacuum **112** also operates with the vacuum squeegee **116** to remove waste **162** from the surface **102**, as indicated by arrow **168**. The waste **162** is then deposited in one or more waste recovery tanks **170** or other location, as will be described in greater detail below.

[**0033**] In accordance with one embodiment, the vacuum **112** is selectively placed in vacuum communication with the vacuum squeegee **116** and the vacuum extractor tool **114** using a vacuum path selector **172**. Vacuum communication is intended to mean that a vacuum path is opened between the component (i.e., squeegee or extractor tool) and the low pressure vacuum generated by the vacuum **112**. Once established, the vacuum communication allows for liquid and/or solid waste **162** to be sucked up through an opening of the vacuum squeegee **116** and/or the extractor tool **114** and deposited in the waste recovery tank **170**, as indicated in **FIG. 3**. Embodiments of the vacuum path selector **172** include one or more valves (e.g., multi-way valve, Y-valves) and other conventional vacuum path controlling components. The vacuum paths **173**, such as vacuum path **174** coupled to the vacuum squeegee **116** or vacuum path **176** coupled to the extractor tool **114**, are formed by vacuum conduit or tubing. In accordance with one embodiment, multiple components or paths can be placed in vacuum communication with the vacuum **112** using the vacuum path selector **172**.

[**0034**] In accordance with another embodiment, the cleaner **100** includes separate vacuums **112** for the vacuum squeegee **116** and the extractor tool. With such a configuration, the vacuum path selector may be discarded or disconnected from the vacuum path of the vacuum squeegee **116**.

[**0035**] In another embodiment, vacuum ports corresponding to the various vacuum paths **173** are made accessible by the operator of the cleaner **100**. The coupling of one of the vacuum ports to the vacuum port that is in vacuum communication with the vacuum **112** can be made by manually connecting a tubing section to the appropriate ports.

[**0036**] The vacuum extractor tool **114** can take on various conventional forms depending on its purpose. The extractor tool generally extends widthwise across the surface **178** of the cleaning tool **128** or the surface **112**, from which waste **162** is to be extracted. Multiple extractor tools **114** can be used to cover large widths. It is understood by those skilled in the art that extractor tools **114** are used for removing liquid and solid debris from soft surfaces **102**, such as soft floor surfaces and soft soil transfer roll surfaces, and they do not include a squeegee that would render them operable on hard floor surfaces.

[**0037**] One embodiment of the extractor tool **114** is in the form of a roll extractor tool **180**, two of which are shown in **FIGS. 1 and 4**. Each of the roll extractor tools **180** removes liquid and solid waste **162** from one of the soil transfer rolls **134**. The extracted waste travels through vacuum path **182** having branches **184** and **186** and is deposited in the waste recovery tank, as illustrated in **FIGS. 1, 3** and **4**.

[**0038**] Another embodiment of the extractor tool **114** is in the form of a surface extractor tool **188** that is configured to remove liquid and solid waste **162** from the surface **102**. The extracted waste **162** travels through vacuum path **190** and is deposited in the waste recovery tank **170**, as illustrated in **FIG. 5**.

[**0039**] In accordance with one embodiment, the cleaner **100** includes an extractor tool lift **192** that allows the surface extractor tool **188** to be raised above the surface **102** (as shown in **FIGS. 4, 6** and **7**) when not in use and lowered into an operating position (shown in **FIGS. 2 and 5**) for use in a deep extraction cleaning operation, in which the surface extractor tool **188** engages the surface **102**. One exemplary extractor tool lift **192**, shown in **FIG. 2**, includes a main support **194** connected to either the cleaning head **108** or the mobile body **106**. The surface extractor tool lift **192** also includes guide members **196** attached to the surface extractor tool **188** that slide within slots in a side plate **198** of the main support **194**. A second side set of guide members and side plate are provided on the opposing side of the extractor tool lift and surface extractor tool. A spring **200**, compressed between a top surface of the surface extractor tool **188** and the bottom surface of a cross plate **202** of the main support **194**, biases the surface extractor tool **188** in the lowered or operating position. The surface extractor tool **188** can be held in the raised position manually using a locking mechanism **204** (e.g., a pin) or a suitable actuator mechanism. Alternatively, the extractor tool lift **192** can include a motor to raise and lower the surface extractor tool **188**.

[**0040**] The vacuum squeegee **116** is a component of a fluid recovery device that is conventionally used only in dedicated hard floor surface cleaners. The vacuum squeegee **116** generally comprises a squeegee **210** connected to frame **212**. The squeegee **210** extends across the width of the cleaner **100** or the cleaning swath of the cleaning head **108**. A vacuum port **214** is positioned to receive waste collected by the squeegee **210**, such as, for example, adjacent the surface **102** at the widthwise center of the squeegee **210**. During operation, the squeegee **210** engages the surface **102** and collects soiled cleaning liquid waste **162** as the cleaner **100** moves along the surface **102** in a forward direction, as indicated by arrow **216** in **FIG. 6**. One embodiment of the squeegee **210** includes a concave shape that directs the collected soiled cleaning liquid waste **162** toward the vacuum port **214**. When vacuum communication is established between the vacuum port **214** and the vacuum **112**, the waste **162** is sucked through the vacuum port **214** and the connected vacuum path **174** and deposited into the recovery tank **170**, as illustrated in **FIGS. 3 and 6**.

[**0041**] A squeegee lift **217**, shown in **FIG. 2** and schematically in **FIG. 3**, is used to move the vacuum squeegee **116** from a raised position off the surface **102** (shown in **FIGS. 2, 4** and **5**) to a lowered operating position (shown in **FIGS. 6 and 7**), in which the squeegee engages the surface **102**. One exemplary embodiment of the squeegee lift **217** includes a cable **218** having one end connected to the frame **212** and another end connected to an actuating lever **220**. The frame **212** is coupled to the mobile body **106** through a suitable pivotal connection (not shown). The operator of the cleaner **100** can raise and lower the vacuum squeegee **116** as desired using the actuating lever **220** which causes the frame **212** and the attached squeegee **210** to move about the pivotal connection to the raised or operating positions. A castor wheel **222** can be coupled to the frame **212** to limit the height at which the squeegee **210** can be lowered.

[0042] The cleaning liquid dispenser **110** is configured to apply a cleaning liquid **230** to one of the surface **102** and the cleaning tool **128** and respectively indicated by arrows **230**A and **230**B of **FIG. 3**. **FIG. 8** is a block diagram of the cleaning liquid dispenser **110** in accordance with embodiments of the invention.

[0043] One embodiment of the cleaning liquid dispenser **110** includes a supply of the cleaning liquid **230** and a pump **232** for driving a flow of the cleaning liquid **230** (arrows) cleaning liquid through tubing to be discharged at a desired location. The cleaning liquid **230** can comprise water or a combination of water and a cleaning agent. In one embodiment, separate supplies of water **234** and cleaning agent **236** are provided. The water **234** can be stored in a tank supported on the mobile body **106**, while the cleaning agent is provided in a separate container, such as a fixed tank or removable container or cartridge. A mixing member **238** combines a flow of water **240** with a flow of the cleaning agent **242** at a desired dosage to form the flow of cleaning liquid **230**.

[0044] The dosing of the flow of cleaning agent **242** into the flow of water **240** can be accomplished using a venturi injector or through use of a dosing pump **244**. In accordance with one embodiment, the flow of cleaning agent **242** is less than 10.0 cubic centimeters per minute.

[0045] In order to accommodate different cleaning liquids and different cleaning liquid flow rates that may be desired for soft and hard floor cleaning operations, one embodiment of the cleaning liquid dispenser **110** includes separate soft and hard floor cleaning liquid dispenser **250** and **252**, respectively. The cleaning liquid dispensers **250** and **252** generally have the form of the embodiments of the cleaning liquid dispenser **110** described above, but can share components, such as pumps and the water supply, for example. In one embodiment, the soft floor cleaning liquid dispenser **250** utilizes a different cleaning agent and/or provides a lower volumetric flow rate of cleaning liquid **230**S than the flow of the cleaning liquid **230**H of the hard floor cleaning liquid dispenser **252**. The lower volumetric flow rate is essential in soft floor cleaning operations in order to prevent long drying times for the soft floor surface **102** and to prevent the development of mold. Additionally, hard floor surface **102** cleaning operations generally desire a complete wetting of the hard floor surface **102** in order to remove embedded or debris that has dried on the surface **102**. If necessary, a valve **254** can be used to switch between the flow of soft floor cleaning liquid **230**S and the flow of hard floor cleaning liquid **230**H.

[0046] Another embodiment of the cleaning liquid dispenser **110** includes one or more nozzles, or other fluid distributor, for discharging the flow of cleaning liquid **230** to the desired location. In one embodiment, the cleaning liquid dispenser **110** includes one or more nozzles **260** or tubing for directing the flow of cleaning liquid **230** onto the cleaning tool **128**, such as the soil transfer rolls **134** (**FIG. 4**) or the hard floor scrub brush (**FIG. 6**). In accordance with another embodiment, the cleaning liquid dispenser **110** includes one or more nozzles **262** for directing the cleaning liquid **230** onto the surface **102**, preferably in front of the cleaning tool **128**. In yet another embodiment, the cleaning liquid dispenser **110** includes one or more nozzles **264** for directing the cleaning liquid **230** onto both the surface **102** and the cleaning tool **128**, as shown in **FIGS. 4 and 5**. One or more valves **266** can control the flow of cleaning liquid **230** to the desired nozzle or location.

[0047] In accordance with yet another embodiment of the invention, the cleaning liquid dispenser **110** is configured to dispense the flow cleaning liquid **230** to the desired surface **102** as a foam. In general, soft floor cleaning operations utilize a dry foam to avoid overly wetting the soft floor surface **102** and long drying times, whereas hard floor surface cleaning operations may utilize a relatively wet foam that is suitable for completely wetting the hard floor surface **102**. In accordance with one embodiment, at least one of the nozzles **260**, **262** or **264** is an aerating nozzle that converts the flow of cleaning liquid **230** into a foam, which is then discharged to either the surface **102** in front of the cleaning tool **128**, on the cleaning tool **128**, or both. Alternatively, an aerating device located upstream of the nozzles can be used to convert the cleaning liquid into a foam.

[0048] Another aspect of the present invention is directed to methods of cleaning hard and soft floor surfaces **102** using embodiments of the cleaner **100** described above. As mentioned above, **FIG. 4** illustrates embodiments of a soil transfer soft floor cleaning mode operation for the cleaner **100**. Initially, the soil transfer rolls **134** are installed in the cleaning head **108** and lowered to the operating position by the head lift **132**, the vacuum squeegee **116** is moved to the raised position using the squeegee lift **217**, and the surface extractor tool **114** is moved to the raised position using the tool lift **192**, as shown in **FIG. 4**. Additionally, vacuum communication is established between the vacuum **112** and the roll extractor tools **180** through the paths **182**, **184** and **186**. Next, the soil transfer rolls **134** are wetted with cleaning liquid **230** discharged through nozzle **260**, then extracted by operation of roll extractor tools **180** to remove soiled cleaning liquid **162** from the rolls **134**. Nozzle **264** can also be activated if desired to spray the surface **102** and/or the leading roll **134**. The rolls are rotated by operation of the motor(s) **130** and wipe the surface **102**, which transfers soil from the surface **102** onto soil transfer rolls **134**. The rotation of the rolls **134** in the directions indicated by arrows **136** and **138** results in different portions of the soil transfer rolls **134** being wetted with the cleaning liquid **230**, extracted by roll extractors **180**, or wiped against the surface **102**.

[0049] The roll extractors **180** engage the surfaces **178** of the rolls **134** and are placed in vacuum communication with the vacuum **112**, which removes some of the just deposited cleaning liquid **230** and soil previously transferred from the surface **102**. As a result, the wetness of the rolls **134** is reduced from the initially sprayed condition by the extraction of some of the cleaning liquid **230** by the roll extractors **180**.

[0050] As the rolls **134** are revolved, they engage the soft floor (e.g., carpet fibers) **102** and cause soil to be transferred from the carpet fibers to the rolls **134**. After engaging and wiping the surface **102**, the rolls **134** are further rotated and sprayed again with cleaning liquid **230** by nozzle **260**. Subsequently, the surfaces **178** of the rolls **134** are vacuum extracted to remove the soiled cleaning liquid **162** from the rolls **134**, which is conveyed into the recovery tank **170**.

[0051] **FIG. 5** illustrates embodiments of a deep extraction cleaning mode of operation, in which the cleaner **100** functions similarly to known carpet extractors. If necessary,

the soil transfer rolls **134** are replaced with the extractor brushes **140**, the cleaning head **108** and the surface extractor **188** are moved to their operating positions, and the vacuum squeegee **116** is moved to the raised position, as shown in **FIG. 5**. Additionally, vacuum communication is established between the vacuum **112** and the surface extractor tool **188** through the vacuum path **190**. The cleaner **100** operates while moving in the forward direction indicated by arrow **216**. The cleaning liquid dispenser **110** discharges cleaning liquid **230** to the surface **102** through nozzle(s) **264** or uses nozzle(s) **262** to direct cleaning liquid **230** onto both the surface **102** and the leading extractor brush **140**. The extractor brushes **140** are driven via the motor(s) **130** to engage the floor surface **102** and transfer soil into a soiled cleaning solution **162**. The extractor brushes **140** may include bristles to facilitate soil transfer. In one embodiment, the direction of rotation of the extractor brushes **140** is indicated by arrows **142** and **144**. As the cleaner **100** progresses across the floor surface **102**, the surface extractor **188** engages the wetted portion of the surface **102** to remove the soiled cleaning liquid **162** from the surface **102**. The soiled cleaning liquid **162** is moved through the vacuum path **190** and into the waste recovery tank **170** by operation of the vacuum **112**.

[**0052**] The deep extraction soft floor cleaning operation utilizes a larger volume of cleaning liquid **230** per unit area than the soil transfer cleaning operation performed by the cleaner **100**. As a result, the surface **102** requires a longer drying time following a deep extraction cleaning operation than that required following a soil transfer cleaning operation. However, the drying times for both the deep extraction cleaning operation and the soil transfer cleaning operation can be reduced by utilizing the cleaning liquid in an aerated or foam state.

[**0053**] **FIG. 6** illustrates embodiments of the hard floor scrubbing mode of operation for the cleaner **100**. Initially, the hard floor scrub brush **146** is installed in the reconfigurable cleaning head **108**, or a hard floor cleaning head **108** having the scrub brush **146** is attached to the mobile body **106**. Also, the cleaning head **108** and the vacuum squeegee **116** are moved to their operating positions and the surface extractor tool **188** is moved to the raised position, as shown in **FIG. 6**. Vacuum communication is also established between the vacuum **112** and the vacuum port **214** of the vacuum squeegee **116** through the vacuum path **174**. Next the cleaning liquid dispenser **110** wets the surface **102** with cleaning liquid **230** by discharging the cleaning liquid **230** through the nozzle **262** and/or wets the surface **102** and the scrub brush **146** by discharging cleaning liquid **230** through tubing **260** that is internal to the scrub brush **146**. The motor **130** rotates the scrub brush **146** as it engages the wetted surface **102** and forms soiled cleaning liquid **162**. As the cleaner **100** moves in the forward direction **216** the soiled cleaning liquid **162** is collected by the squeegee **210** and directed toward the vacuum port **214**. The soiled cleaning liquid **162** is then sucked through the vacuum port **214**, through the vacuum path **174** and discharged into the waste recovery tank **170**.

[**0054**] When the cleaning tool **128** comprises hybrid rolls **152** configured for both soil transfer soft floor cleaning operations and hard floor cleaning operations, the cleaner **100** operates in substantially the same manner as described above with respect to the soil transfer cleaning mode of operation. The benefit of the hybrid rolls **152** is that they can be used to perform a hard floor cleaning operation. The conversion to the hard floor cleaning mode involves lowering the vacuum squeegee **116** to the operating position, establishing vacuum communication between the vacuum squeegee **116** and the vacuum **112** through the path **174** and discharging cleaning liquid **230** onto the surface **102**, as shown in **FIG. 7**. The surface **102** is scrubbed by the rotating rolls **152**. The soiled cleaning liquid left behind by the rolls is collected by the vacuum squeegee **116** and transferred to the waste recovery tank **170** through the path **174**.

[**0055**] Additional embodiments of this hybrid hard floor cleaning mode include applying cleaning liquid **230** to the hybrid rolls **152** through, for example, nozzle(s) **260** or **262**, and establishing vacuum communication between the vacuum **112** and the roll extractor tools **180** through the paths **182**, **184** and **186**. As a result, one embodiment includes extracting the soiled cleaning liquid **162** from the rolls **152** and transferring the soiled cleaning liquid **162** to the waste recovery tank **170** through the path **182**.

[**0056**] Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention.

What is claimed is:

1. A floor cleaner comprising:

a mobile body configured to travel over a surface;

a motorized cleaning head connected to the mobile body and comprising a cleaning tool;

a cleaning liquid dispenser configured to apply a cleaning liquid to one of the surface and the cleaning tool;

a vacuum supported on the mobile body;

a first vacuum extractor tool configured for vacuum communication with the vacuum through a first vacuum path; and

a vacuum squeegee connected to the mobile body.

2. The cleaner of claim 1, wherein the vacuum squeegee is configured for vacuum communication with the vacuum through a second vacuum path.

3. The cleaner of claim 1, wherein the cleaning tool comprises a hard floor surface cleaning tool.

4. The cleaner of claim 1, wherein the cleaning tool comprises a hard floor scrub brush.

5. The cleaner of claim 1, wherein the cleaning tool comprises a soft floor surface cleaning tool.

6. The cleaner of claim 5, wherein the cleaning tool comprises one of a soil transfer roller and a soft floor extraction brush.

7. The cleaner of claim 1, wherein the first vacuum extractor tool is configured to remove liquid from a surface of the cleaning tool.

8. The cleaner of claim 1, wherein the first vacuum extractor tool is configured to engage the surface.

9. The cleaner of claim 8, further comprising an extractor tool lift coupled to the first vacuum extractor tool, the lift mechanism configured to move the first vacuum extractor tool relative to the mobile body between a raised position, in which the first vacuum extractor tool is displaced from the surface, and an operating position, in which the first vacuum extractor tool engages the surface.

10. The cleaner of claim 2, further comprising a second vacuum extractor tool configured for vacuum communication with the vacuum.

11. The cleaner of claim 10, wherein the first and second vacuum extractor tools are each configured to engage the cleaning tool.

12. The cleaner of claim 10, wherein:

the first vacuum extractor tool is configured to engage the cleaning tool and the second vacuum extractor tool is configured to engage the surface; and

the second vacuum extractor tool is configured for vacuum communication with the vacuum through a third vacuum path.

13. The cleaner of claim 12, further comprising a vacuum path selector means for controlling vacuum communication between the vacuum and the first vacuum path, the second vacuum path and the third vacuum path.

14. The cleaner of claim 2, further comprising a vacuum path selector means for selectively opening and closing vacuum communication between the vacuum and the first and second vacuum paths.

15. A floor cleaner comprising:

a mobile body configured to travel over a surface;

a motorized cleaning head connected to the mobile body and comprising a cleaning tool;

a cleaning liquid dispenser configured to apply a cleaning liquid to one of the surface and the cleaning tool;

a vacuum supported on the mobile body;

a first vacuum path configured for vacuum communication with the vacuum;

a second vacuum path configured for vacuum communication with the vacuum;

a first vacuum extractor tool configured for vacuum communication with the vacuum through the first vacuum path; and

a vacuum squeegee connected to the mobile body and configured for vacuum communication with the vacuum through the second vacuum path.

16. The cleaner of claim 15, further comprising a vacuum path selector means for selectively opening and closing vacuum communication between the vacuum and the first and second vacuum paths.

17. The cleaner of claim 15, wherein the first vacuum extractor tool is configured to remove liquid from a surface of the cleaning tool.

18. The cleaner of claim 15, wherein the first vacuum extractor tool is configured to engage the surface.

19. The cleaner of claim 18, further comprising an extractor tool lift coupled to the first vacuum extractor tool, the lift mechanism configured to move the first vacuum extractor tool relative to the mobile body between a raised position, in which the first vacuum extractor tool is displaced from the surface, and an operating position, in which the first vacuum extractor tool engages the surface.

20. The cleaner of claim 15, wherein the cleaning tool is selected from the group consisting of a soft floor cleaning tool and a hard floor cleaning tool.

21. A floor cleaner comprising:

a mobile body configured to travel over a surface;

a motorized cleaning head connected to the mobile body and comprising a cleaning tool;

a cleaning liquid dispenser configured to apply a cleaning liquid to one of the surface and the cleaning tool;

a vacuum supported on the mobile body;

a first vacuum path configured for vacuum communication with the vacuum;

a second vacuum path configured for vacuum communication with the vacuum;

a third vacuum path configured for vacuum communication with the vacuum;

a first vacuum extractor tool configured for vacuum communication with the vacuum through the first vacuum path;

a second vacuum extractor tool configured for vacuum communication with the vacuum through the second vacuum path; and

a vacuum squeegee connected to the mobile body and configured for vacuum communication with the vacuum through the third vacuum path.

22. The cleaner of claim 21, wherein the first and second vacuum extractor tools are each configured to remove liquid from a surface of the cleaning tool.

23. The cleaner of claim 21, wherein the first vacuum extractor tool is configured to remove liquid from a surface of the cleaning tool and the second vacuum extractor tool is configured to engage the surface.

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