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(54) **SUSPENSION FOR A SURFACE MAINTENANCE APPLIANCE**

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(57) **ABSTRACT**

An improved suspension system for coupling a surface maintenance tool or appliance to a surface maintenance machine is disclosed. In preferred embodiment, the suspension system includes a 4 bar linkage which permits the surface maintenance tool to be raised and lowered relative to the surface maintenance machine into selective contact with the floor surface, a spring assembly transferring spring force to the surface maintenance tool, and a selectively controllable actuator connected to the spring assembly for controlling a level of the spring force so that a controlled level of surface maintenance tool work is performed upon the floor surface.

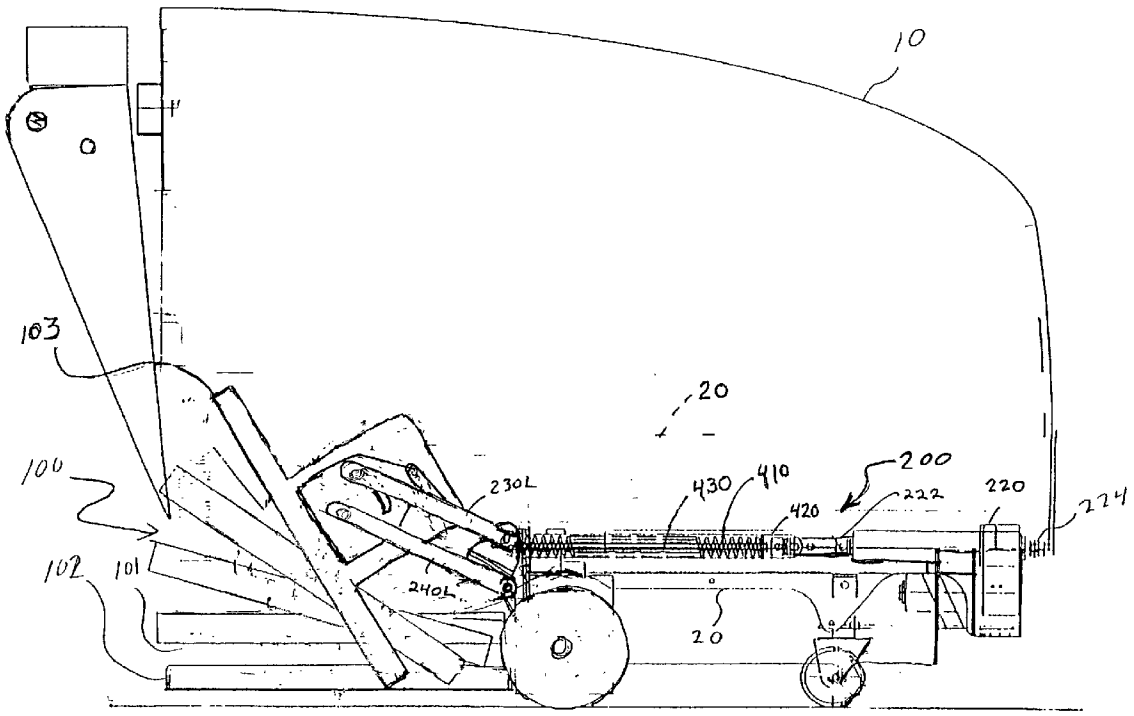
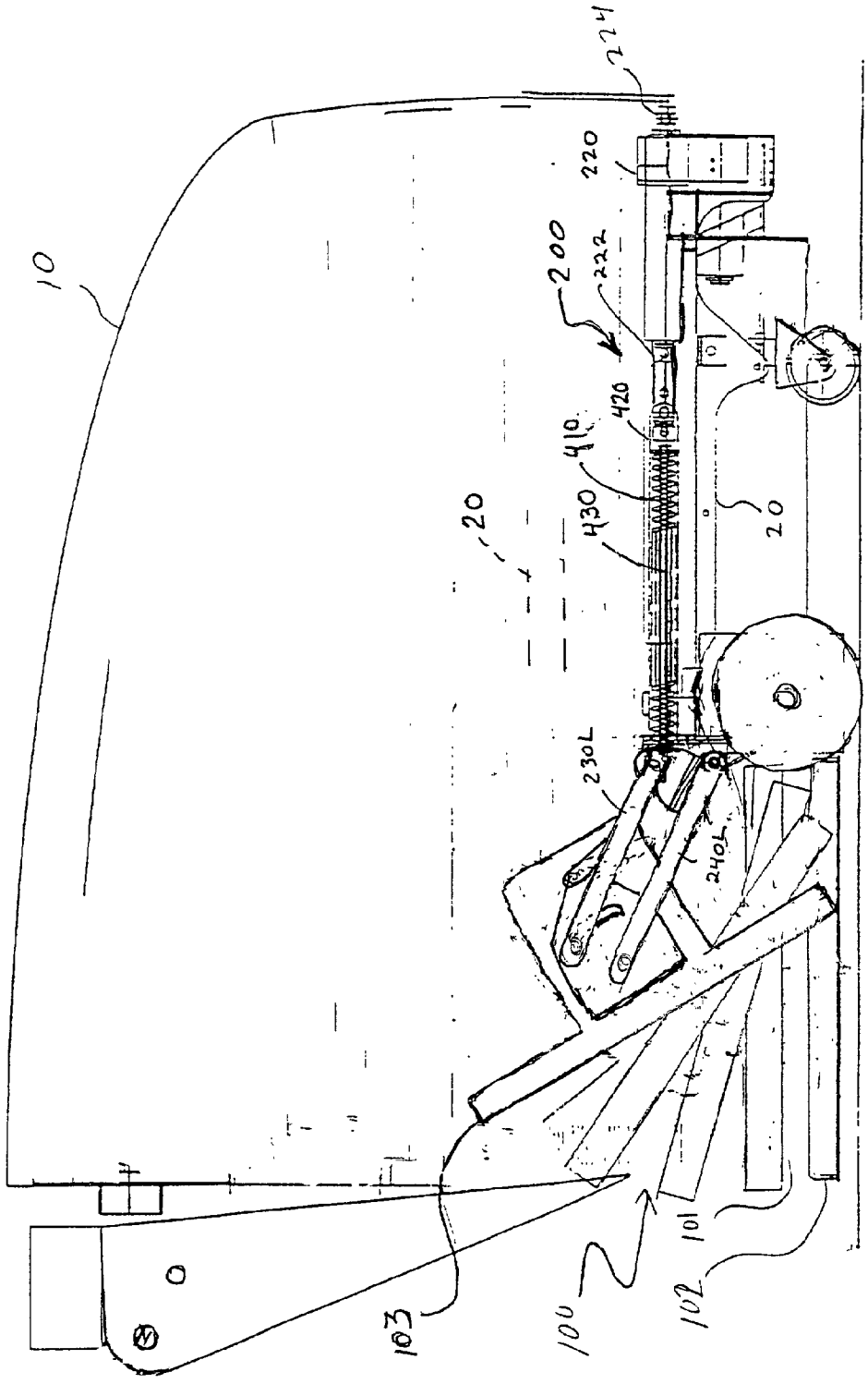


FIG. 1



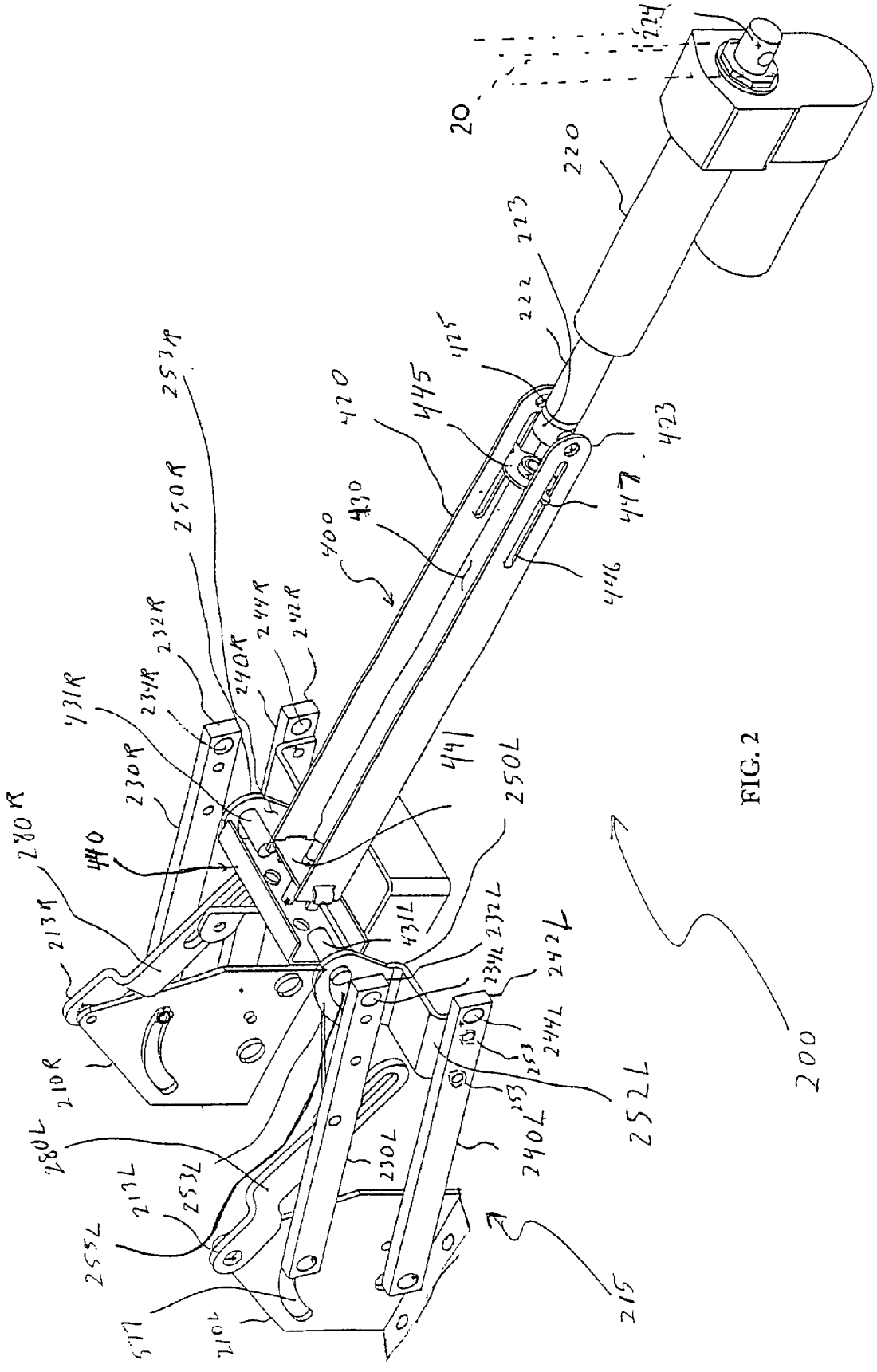

20
1224
220
222
223
1175
445
420
423
400
430
447
446
441
250L
250R
253R
240R
244R
242R
232R
234R
231R
230R
280R
440
213R
210R
280L
213L
253L
255L
217
210L
230L
240L
253
244L
242L
234L
232L
231L
215
2522
200

FIG. 2

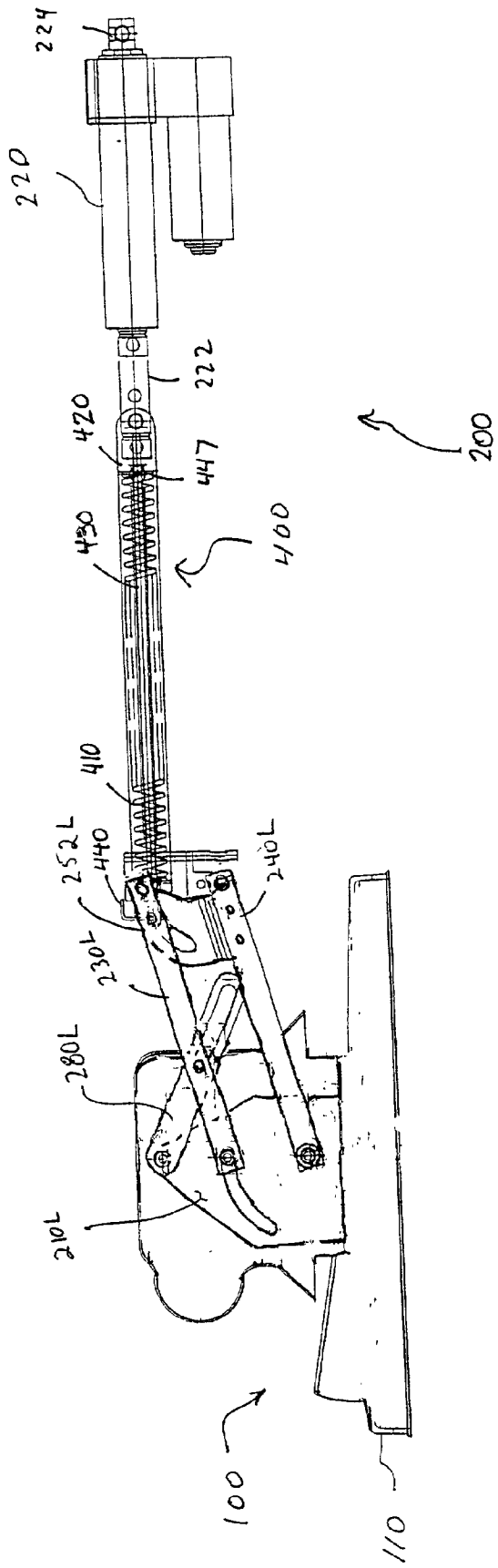

224
220
222
420
447
200
430
400
410
252L
440
240L
230L
280L
210L
100
110

FIG. 3

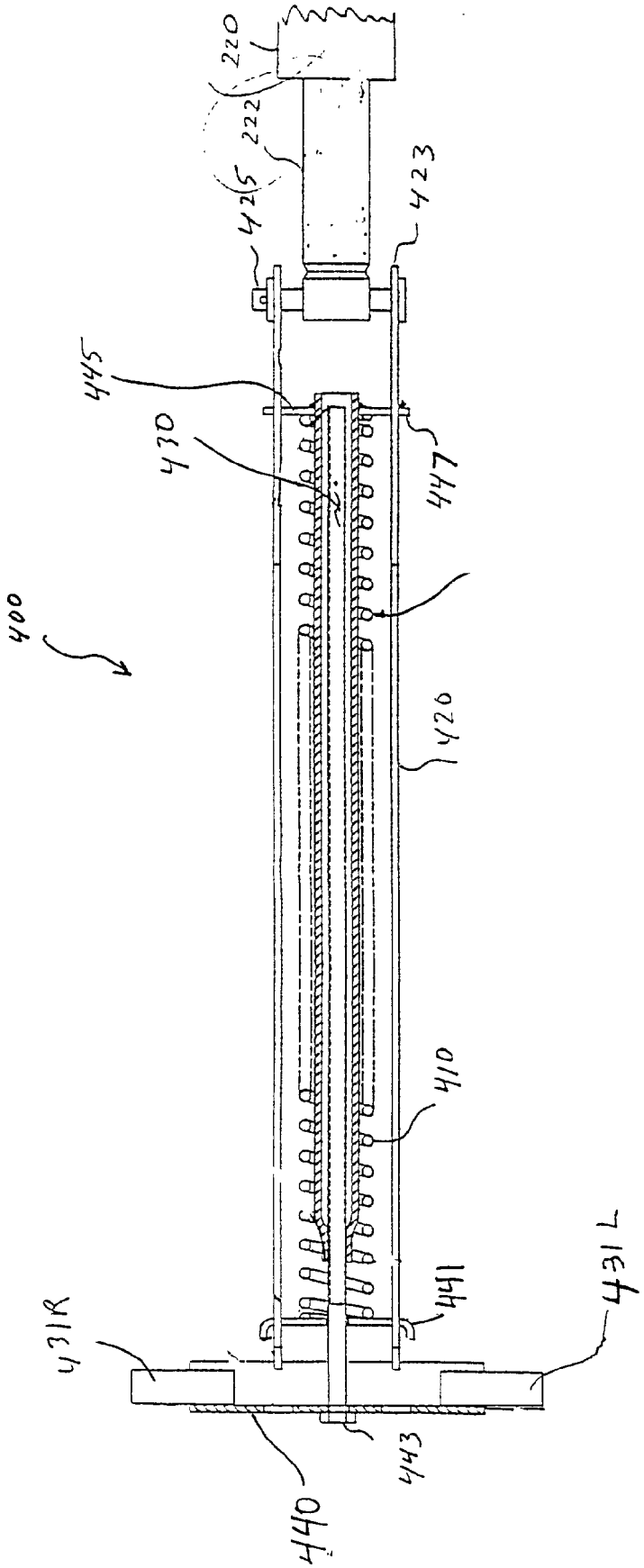


FIG. 4

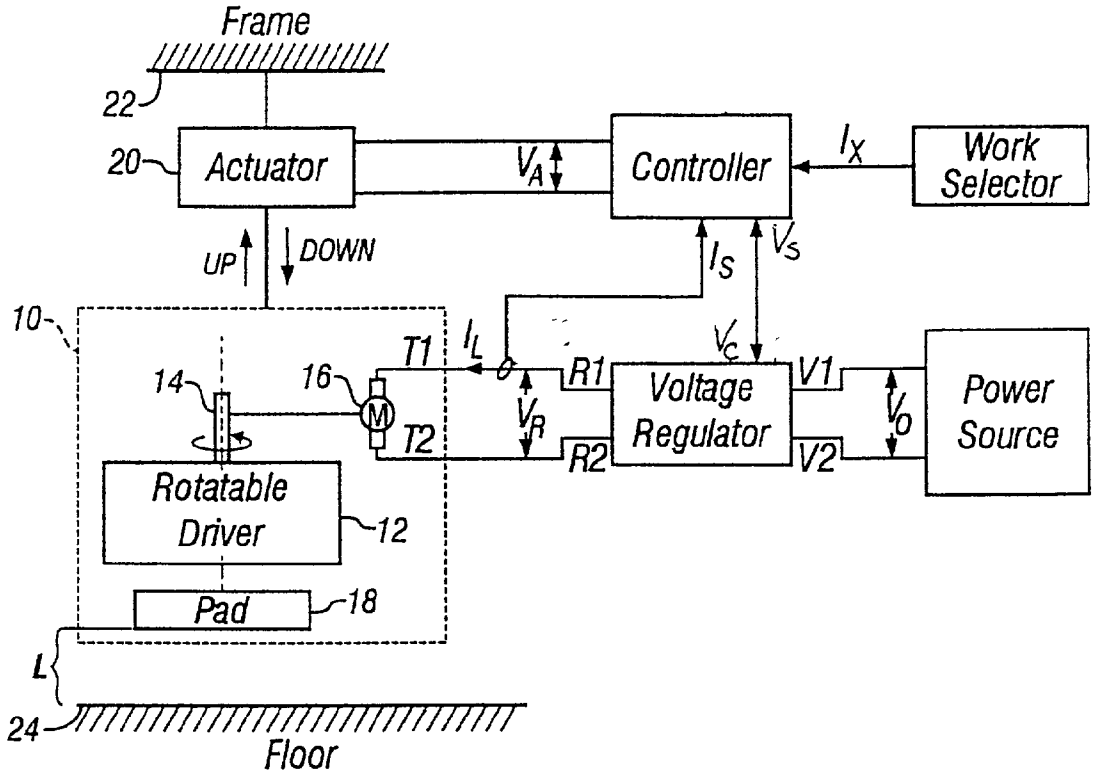

Frame
22
20
Actuator
V_A
Controller
I_X
Work Selector
UP
DOWN
I_S
V_S
10
I_L
V_C
T1
14
16
M
T2
R1
R2
V_R
Voltage Regulator
V1
V2
V_O
Power Source
Rotatable Driver
12
Pad
18
L
24
Floor

FIG. 5

SUSPENSION FOR A SURFACE MAINTENANCE APPLIANCE

RELATED APPLICATION

[0001] This application claims the benefit of priority of U.S. Provisional Patent Application No. 60/292,675, filed on May 21, 2001, the disclosure of said application being incorporated by reference herein.

FIELD OF THE INVENTION

[0002] The present invention relates generally to surface maintenance or conditioning machines, and particularly those machines employing one or more surface maintenance or conditioning appliances or tools that perform one or more tasks including, among others, scrubbing, sweeping, and polishing or burnishing. The more specifically, the present invention is particularly directed to a suspension system for a surface maintenance appliance, and specifically a burnishing assembly.

BACKGROUND OF THE INVENTION

[0003] Surface maintenance machines that perform a single surface maintenance or surface conditioning task are, of course, well known. Surface maintenance machines are generally directed to applications such as floor surfaces, or simply floors. The term floor, as used herein, refers to any support surface, such as, among others, floors, pavements, road surfaces, ship decks, and the like.

[0004] Commonly floor or surface maintenance machines are constructed having a single surface conditioning appliance or system so as to only sweep, others to scrub, while still others only to polish or burnish. It is of course possible to construct a single surface maintenance machine to perform one or more of the aforementioned surface maintenance tasks.

[0005] One example of a multi-task floor conditioning machine is disclosed in the U.S. Pat. No. 3,204,280, entitled, "Floor Cleaning & Waxing Machine," issued to Campbell, the enter disclosure of which is incorporated by reference herein in its entirety for any and all purposes. Another is disclosed in U.S. Pat. No. 4,492,002, entitled, "Floor Cleaning Machine," by inventors Waldhauser, et al, the entire disclosure of which is incorporated by reference herein in its entirety for any and all purposes. Disclosed therein is a forward sweeper assembly followed by a scrubber assembly that is followed by a squeegee assembly.

[0006] Yet, another example of a multi-task floor conditioning machine is disclosed in a PCT application having publication WO 00/74549, published Dec. 14, 2000, entitled, "Floor Cleaning Machine," by inventors Thomas, et al, the entire disclosure of which is incorporated by reference herein in its entirety for any and all purposes. The machine disclosed therein performs the task of sweeping, scrubbing, and burnishing, and includes a squeegee assembly in combination with a vacuum system for removing cleaning solution from a floor subsequent to a cleaning and scrubbing operation.

[0007] As illustrated in WO 00/74549, thereshown is a single unitary walk-behind machine that is transportable across a floor. Successively attached to the machine, from front to back, are independent floor maintenance systems. At the forward section of the machine is a sweeping system. At the rearward section of the machine—machine steering control—is a burnishing system. In between the sweeping system and the burnishing system is a scrubbing system including forward scrubbing brushes coupled to a cleaning solution dispensing system and rearward following squeegees coupled to a liquid vacuum system for recovering expended cleaning solution.

[0008] Burnishing systems generally include a scheme for controlling the degree of burnishing applied to a floor surface depending upon the type of floor surface intended to be burnished. Burnishing systems well known in the art commonly include a driver assembly which includes a working appliance or tool such as a pad or brush affixed to a driver that is rotatably driven by a driver motor. The driver assembly of the burnishing systems of the prior art have been selectively raised and lowered by an actuator so as to achieve an intended force or pressure against a floor surface intended to be polished or burnished.

[0009] Scrubbing systems are analogous to burnishing systems, and are also well known in the art. Scrubbing systems commonly include a driver assembly including rotatable scrubber in the form of a brush, pad, or the like, and a scheme for controlling the degree of scrubbing applied to a floor surface depending upon the type of floor surface intended to be scrubbed. Too much scrubbing of course may deleteriously affect the floor surface requiring further maintenance. The scrubber driver assemblies for scrubbing systems, like burnishing systems, are of course well known in the art and commonly include one or more rotatable brushes driven by a driver motor affixed to a scrubber head. Scrubber heads of the prior art have been selectively raised and lowered by an actuator coupled to the driver so as to achieve an intended force or pressure of the brush against a floor surface intended to be scrubbed. Examples of the latter are taught in U.S. Pat. Nos. 4,757,566; 4,769,271; 5,481,776; 5,615,437; 5,943,724; and 6,163,915, the entire disclosures of which are incorporated by reference herein in its entirety for any and all purposes.

[0010] Common to some control systems of the aforementioned prior art patents is the employment of a current sensor that monitors the current drawn by the driver motor. In some of the aforementioned systems of the prior art a "pressure sensor" is employed that is representative of the pressure of the scrubber head against the floor. Still others attempt to control torque load on the motor indicated by the sensed motor current.

[0011] Sweeper systems are also analogous to burnishing systems. Sweeper systems commonly include a rotatable sweeper system brush driven by a driver motor. Like burnishing and scrubbing systems the sweeper system brush may be lowered and raised relative to a floor, which may more or less affect the floor surface.

[0012] Commonly, floor conditioning machines are powered by a rechargeable battery supply. Of course, the battery voltage applied to the various floor conditioning systems or appliances, and particularly to the driver motor, will decay in relation to the energy discharged by the battery and the total time of discharge. With respect to burnishing systems, the mechanical burnishing power delivered to the floor is therefore dependent upon the voltage and current delivered to the driver motor.

[0013] Burnishing appliances or systems on such floor maintenance machines have several factors that place design demands on the suspension system from the floor maintenance machine that are suspended. This is so since commonly the burnishing pad is somewhat surrounded in part by peripheral portion of the driver and is surrounded by an attached skirt extending from peripheral portions of the driver—the skirt preventing dust and debris from being injected into the environment. In operation, upon powering of the burnishing assembly driver motor, a vacuum is established within the chamber formed by the burnishing system driver and skirt. This in turn causes a vacuum which tends to pull the burnishing assembly toward the floor. This vacuum may be controlled by way of providing breather vents or ports in the skirt.

[0014] It should be understood that as the burnishing assembly suspended from the frame of a floor maintenance machine is pulled toward the floor by the aforesaid vacuum greater load upon the driver motor results as well increased working power or force against the floor results, the magnitude of which is dependent upon the type of floor surface intended to be burnished or polished. Driver motor load current controllers known in the prior art burnishing systems or scrubber systems, may of course be employed to more or less yield substantially controlled working power or force against the floor surface, as well as prevent drive motor burn out.

SUMMARY OF THE INVENTION

[0015] An object of the present invention is to provide a suspension system for a floor maintenance appliance suspended from a frame associated with a floor maintenance machine.

[0016] An object of the present invention is to provide a suspension system for burnishing appliance or assembly suspended from a frame associated with a floor maintenance machine.

[0017] A variable load suspension system has been disclosed for varying the work force of a surface maintenance appliance upon a surface intended to be affected. In one exemplary embodiment, a series combination of an actuator and a spring assembly is coupled to a frame at one end, and the other end thereof is coupled to the surface maintenance appliance by way of an appropriate linkage. In the preferred embodiment of the invention, the spring assembly, and specifically the spring, generally extends in the direction of transport of the surface maintenance machine **10**, and the actuator causes motion transverse to the surface intended to be affected.

[0018] The actuator and driver motor of the surface maintenance appliance are intended to be controlled by any of the aforementioned control systems known in the art as well as others without departing from the true spirit and scope of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] **FIG. 1** is a side view of a walk behind surface maintenance machine employing a suspension system in accordance with the present invention for suspending a burnishing system.

[0020] **FIG. 2** is a partial perspective view of the suspension system assembly in accordance with the present invention.

[0021] **FIG. 3** is a side view showing further details of the suspension system assembly illustrated in **FIG. 2**.

[0022] **FIG. 4** is top plan view illustrating suspension system components in accordance with the present invention.

[0023] **FIG. 5** is a schematic block diagram of an exemplary embodiment of a control system for a floor maintenance appliance for controlling the work output delivered to a floor surface.

DETAILED DESCRIPTION OF THE INVENTION

[0024] Illustrated in **FIG. 1** is walk behind surface conditioning machine **10** in accordance with the present invention. A burnishing assembly generally indicated by numeral **100** is suspended from a frame **20** by way of a suspension system assembly in accordance with the present invention generally indicated by numeral **200**, and particularly illustrated in **FIG. 2** as will be described in further detail herein. **FIG. 1** graphically depicts the available range of motion of the burnishing head or assembly **100** when coupled to the frame in accordance with the present invention. Namely, a transport position **101**, lowered operating position **102**, and pad changing position **103**.

[0025] Illustrated in **FIG. 2** is a perspective view of the suspension system **200** in accordance with the present invention. In **FIG. 2**, burnishing assembly **100** has been omitted. Suspension system **200** includes an actuator **220** pivotally coupled to frame **20** through coupling member **224**, and having an actuator rod **222** pivotally coupled to a spring assembly **400** (not shown in **FIG. 2**, shown in **FIG. 4**). Spring assembly **400** is coupled to a 4-point or four parallel bar linkage system **215** through coupling brackets **250**L and **250**R.

[0026] A pair of mounting bracket **210**L and **210**R is intended to be rigidly attached to the burnishing assembly driver member **110** upon which a driver motor is generally mounted.

[0027] Burnishing assembly **100** is coupled to frame **20** by way of the 4-point or 4-bar linkage **215** including bars **230**L, **230**R, **240**L, and **240**R. Ends **232**L, **232**R, **242**L, and **242**R are pivotally coupled to frame **20** (not shown) by way rotatable mounted pins, bolts, or the like mounted through apertures **234**L, **234**R, **244**L, and **244**R, respectively. The four point linkage system is of course well known for generally lifting and lowering an assembly with generally transverse movement relative to the ground plane upon which the assembly may rest. In other words, permits vertical movement while fixed in a lateral position relative to a reference frame, namely the frame **20** of the surface maintenance machine **10**.

[0028] Suspension coupling bracket **250**L has a first end **252**L rigidly secured to bar **240**L by way mounting bolts **253**, welding, or the like. The other end of bracket **250**L is pivotally coupled to one end of spring assembly **400** as will subsequently be described in detail below. Similarly, bracket **250**R has a first end **252**R rigidly secured to bar **240**R by way mounting bolts **253** (not shown) or the like. The other end of bracket **250**R is also pivotally coupled to one end **410** of spring assembly **400**, and is substantially identical to suspension coupling bracket **250**L but is substantially hidden from view in the figures.

[0029] Spring assembly **400** is further described in **FIG. 4**. As illustrated in **FIG. 4**, spring assembly is essentially a preloaded draw spring well known in the art having a helical spring housing **420** enclosing, in part, helical spring **410** with rod **430** passing therethrough. One end **423** of housing **420** is pivotally coupled to actuator rod **222**. The opposite end of rod **430** is affixed to pin assembly member **440** by way of a threaded bolt **443**, or the like. One end of spring **410** is coupled to an anti-rotation plate **445** having extending tabs **447** protruding through slots **446** of housing **420**. The other end of spring **410** engages housing end member **441** of housing **420** through which rod **430** passes therethrough.

[0030] Pin assembly member **440** includes a pair of pins or rod shape members **43** IL and **43** IR intended to be pivotally coupled to suspension coupling bracket end members **253**L and **253**R of suspension coupling brackets **250**L and **250**R, respectively. As illustrated in the figures, rod shaped members **431** pass through, in part, arcuate slots **255**L (**255**R not shown). These slots may be omitted as their function provides for obtaining the appliance assembly position identified as numeral **103** in **FIG. 1** while maintaining pivotal coupling. It should also be noted that suspension coupling brackets **250**L and **250**R are somewhat "s-shaped" so as to permit unobstructed movement of the 4-point suspension system, while at the same time permit 4-point suspension system to be affected, in part, by the combination spring assembly **400** and actuator **220**.

[0031] Actuator **220** includes a mounting member **224** for pivotally coupling actuator **220** to frame **20**. Similarly end member **223** of actuator rod **222** is pivotally coupled to housing end member **423** by way of any suitable pivotal coupling, for example a travis pin assembly or the like as indicated by numeral **425**.

[0032] In an exemplary embodiment of the invention, draw spring assembly may have a free length spring of 29 inches, an installed length of 15 inches (compressed spring) with a 20 lbs.-inch rate of spring force. It is of course should be understood by those skilled in the art that the size of draw spring assembly **400** may be embodied by way of a wide array of physical sizes depending upon the weight of the burnishing assembly, and the available room and cost considerations associated with the surface maintenance machine **10**.

[0033] In operation of the suspension system of the present invention, in the actuator retracted position, the burnishing assembly is the machine transport position indicated by numeral **101** in **FIG. 1** and the assembly is away from the floor surface.

[0034] In the "operate position," the actuator is extended a predetermined amount until the burnishing head makes contact with the floor surface while under the influence of the draw spring assembly **400**. In turn the actuator **220** and burnishing head driver **110** motor may be controlled to achieve regulated work force upon the surface intended to be affected. Actuator **220** is selectively controlled during operation to adjust the degree of spring compression, and hence the degree of spring force transferred by spring assembly **400** to burnishing assembly **100**. Actuator **220** may be a hydraulic actuator (not shown) or other known actuation device appreciated by those skilled in the relevant arts.

[0035] The present invention provides a horizontal packaging technique for achieving variable spring load in the vertical direction of a surface maintenance assembly or appliance, for example burnishing, scrubbing, waxing assemblies, and the like.

[0036] A variable load suspension system has been disclosed for varying the work force of a surface maintenance appliance upon a surface. A series combination of an actuator and a spring assembly is coupled to a frame at one end, and the other end thereof is coupled to the surface maintenance appliance by way of an appropriate linkage. In the preferred embodiment of the invention, the spring assembly **400** generally extends in the direction of transport of the surface maintenance machine **10** (generally parallel with the surface), and the actuator causes motion transverse to the surface intended to be affected.

[0037] It should be recognized that alternatively, the positions of actuator **220** and draw spring assembly **400** could be interchanged as should be recognized by those skilled in the art.

[0038] In accordance with another aspects of the present invention, brackets **210**L and **210**R are provided with arcuate slots **577** whereby pins coupling bar members **230**L and **230**R may be lifted upward from points **213**L and **213**R. With the arcuate slots **577** and corresponding slots **255**L and **255**R in coupling brackets **250**L and **250**R respectively, the entire mechanism may be lifted. Locking members **280**L and **280**R are provided with a slot so that bar members **250**L and **250**R may be pivotally coupled to members **280**L and **289**, respectively, permitting the assembly **100** to be raised to pad changing position as indicated by numeral **103** in **FIG. 1**.

[0039] Referring to **FIG. 5, a** schematic block diagram is illustrated representing one exemplary embodiment of a control system for a floor maintenance appliance that controls the work output delivered to a floor by a rotatable work tool, such as a polishing pad, a scrubber, a brush, etc. Such a control system may be utilized in conjunction with embodiments of the present invention to control linear actuator **220**. Additional aspects of this control system are disclosed in U.S. patent application Ser. No. _____, filed on May 21, 2002, entitled "Control System for a Floor Maintenance Appliance," having a common assignee with the present application, and being incorporated in its entirety by reference herein. In **FIG. 5, a** floor maintenance assembly **10** is configured as a burnishing system suspended from a frame **22** associated with a floor maintenance machine (not shown) by way of an actuator **20**. The actuator **20** is configured to raise and lower the maintenance assembly **10** relative to the floor **24**. Although a burnishing tool is illustrated in the Figures, it should be understood that the maintenance assembly **10** may be configured to perform other types of maintenance tasks, such as sweeping and scrubbing, or a combination of maintenance tasks. As shown in **FIG. 5**, the maintenance assembly **10** includes a rotatable driver **12** having a rotatable shaft **14** coupled to a driver motor **16**. The rotatable work tool for performing the work task is a burnishing pad **18** that is coupled to a rotatable driver **12**. The maintenance assembly **10** and the actuator **20** may be implemented by way of a wide array of components and techniques, many of which have been described in the aforementioned published patents and publications, among others.

[0040] Although the present invention and its advantages have been described in detail, it should be understood that

various changes, substitutions and alterations can be made herein without departing from the spirit and scope of the invention as defined by the appended claims. Moreover, the scope of the present application is not intended to be limited to the particular embodiments of the process, machine, manufacture, composition of matter, means, methods and steps described in the specification. As one of ordinary skill in the art will readily appreciate from the disclosure of the present invention, processes, machines, manufacture, compositions of matter, means, methods, or steps, presently existing or later to be developed that perform substantially the same function or achieve substantially the same result as the corresponding embodiments described herein may be utilized according to the present invention. Accordingly, the appended claims are intended to include within their scope such processes, machines, manufacture, compositions of matter, means, methods, or steps.

1. A surface maintenance machine for operation upon a floor surface, said surface maintenance machine comprising:

a surface maintenance tool coupled to the machine through a plurality of linkages which permit the surface maintenance tool to be raised and lowered relative to the surface maintenance machine into selective contact with the floor surface;

a spring assembly including at least one adjustable spring, said spring assembly being coupled to the surface maintenance tool so that a spring force is transferred to the surface maintenance tool; and

a selectively controllable actuator coupled to the spring assembly, said actuator controlling a level of the spring force so that a controlled level of surface maintenance tool work is performed upon the floor surface.

2. The surface maintenance machine of claim 1, wherein the plurality of linkages comprises a four bar linkage device.

3. The surface maintenance machine of claim 1, wherein the spring assembly is coupled to at least one of the plurality of linkages.

4. The surface maintenance machine of claim 1, wherein the spring assembly includes a spring retained within a spring housing.

5. The surface maintenance machine of claim 1, wherein the actuator is connected to the spring housing.

6. The surface maintenance machine of claim 1, wherein the actuator is an electric actuator.

7. The surface maintenance machine of claim 6, wherein the actuator is an electric linear actuator.

8. The surface maintenance machine of claim 1, wherein the actuator is a hydraulic actuator.

9. The surface maintenance machine of claim 1, wherein the spring assembly is coupled to the surface maintenance machine in a generally parallel orientation relative to the ground surface.

10. The surface maintenance machine of claim 9, wherein the spring assembly is generally elongated and is coupled to the surface maintenance machine so that an elongated dimension of the spring assembly is aligned generally in a direction of machine motion.

11. The surface maintenance machine of claim 1, wherein the spring force transferred to the surface maintenance tool tends to lift the surface maintenance tool away from the floor surface.

12. A suspension device for coupling a surface maintenance appliance to a surface maintenance machine, said suspension device comprising:

a plurality of linkages coupled between the surface maintenance device and the surface maintenance machine, said plurality of linkages permitting the surface maintenance device to be selectively transitioned relative to the surface maintenance machine between a plurality of positions;

a spring assembly having at least one spring, said spring assembly transferring a spring force to at least one of the plurality of linkages and the surface maintenance device; and

a controllable spring actuator in engagement with the spring assembly for selectively controlling the spring force being transferred to the surface maintenance device during operation.

13. The suspension device of claim 12, wherein the plurality of linkages comprises a four bar linkage device.

14. The suspension device of claim 12, wherein the spring assembly is coupled to at least one of the plurality of linkages.

15. The suspension device of claim 12, wherein the spring assembly includes a spring retained within a spring housing.

16. The suspension device machine of claim 12, wherein the actuator is connected to the spring housing.

17. The suspension device of claim 12, wherein the spring assembly is coupled to the surface maintenance machine in a generally parallel orientation relative to the ground surface.

18. The suspension device of claim 17, wherein the spring assembly is generally elongated and is coupled to the surface maintenance machine so that an elongated dimension of the spring assembly is aligned generally in a direction of machine motion.

19. The suspension device of claim 12, wherein the spring force transferred to the surface maintenance tool tends to lift the surface maintenance tool away from the floor surface.

20. The suspension device of claim 12, wherein one of the plurality of positions of the surface maintenance device relative to the surface maintenance machine is a substantially perpendicular orientation relative to a normal operational position.

21. A vehicle for burnishing a floor surface, said vehicle being transportable across the floor surface during a burnishing operation, said vehicle comprising:

a burnishing head including a motor driven burnishing pad;

a plurality of linkages coupled between the burnishing head and the vehicle, said plurality of linkages permitting the burnishing head to be selectively transitioned relative to the vehicle between a plurality of positions;

a spring assembly having at least one spring, said spring assembly transferring a spring force to the burnishing head; and

a controllable spring actuator in engagement with the spring assembly for selectively controlling a burnishing force being transferred to the surface during operation.

22. The suspension device of claim 21, wherein the plurality of linkages comprises a four bar linkage device.

23. The suspension device of claim 21, wherein the spring assembly is coupled to at least one of the plurality of linkages.

24. The vehicle of claim 21, wherein the spring assembly is coupled to the vehicle in a generally parallel orientation relative to the ground surface.

25. The vehicle of claim 24, wherein the spring assembly is generally elongated and is coupled to the vehicle so that an elongated dimension of the spring assembly is aligned generally in a direction of vehicle motion.

26. The vehicle of claim 21, wherein the spring force tends to lift the surface burnishing head away from the floor surface.

27. The vehicle of claim 21, wherein one of the plurality of positions of the burnishing head relative to the vehicle is a substantially perpendicular orientation relative to a normal operational position.

* * * * *