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(54) **Surface treatment machine**

(57) Systems and methods for surface treatment machines with a supplemental drive for rotation of a drum rotor generally include a drive train with a drive motor to operate a drum rotor of the surface treatment machine at a first rotational velocity and a service motor integral to a drive pulley that may rotate the drum rotor at a second rotational velocity; the surface treatment machine may include a freewheeling device or be otherwise capable of activating, engaging, or disengaging either the drive motor or the service motor, or both, so that power output from only one of the drive motor and the service motor is rotationally driving the drum rotor.

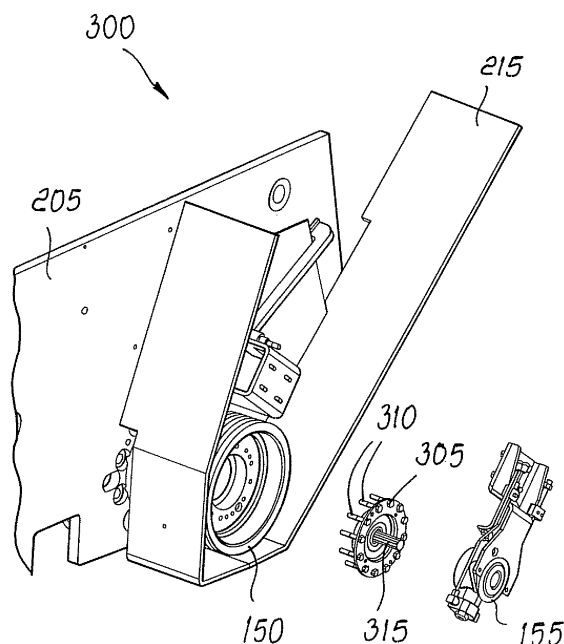


Fig. 3

Description

Field of the Invention

[0001] The present invention relates generally to industrial machines. More specifically, the present invention relates to surface treatment machines with a supplemental drive for rotation of a rotor for inspection, maintenance, or testing purposes, as well as methods of manufacturing and operating the same.

Background of the Invention

[0002] Industrial machines may include mounted work drums that contact a surface over which the industrial machine is operating. These industrial machines may include milling machines or cold planers designed to prepare or treat a surface such as a road surface, pavement, soil, or earth. The work drum, which may have a coarse surface or attachments protruding from its surface, is rotationally driven by a motor that forms part of a drive train that includes a series of pulleys connected by a drive belt that is used to rotate the work drum so that it contacts the surface with a force sufficient to alter, treat, or even remove the surface to a predetermined depth. For operations such as milling a paved road surface, where the work drum contact with the road surface results in destruction and removal of the asphalt, it is plain to see that significant force is required and that the work drum comes into powerful contact with the surface.

[0003] These industrial machines in general, and the work drums in particular, are subject to significant wear and tear due to the nature of their use. Pieces of pavement or other surface matter from the milling process may damage the work drum and any attachments, or get caught in various areas of the industrial machine where they can cause a malfunction. The work drum and any associated attachments have limited lifetimes and eventually wear and need to be replaced in a timely and efficient manner.

[0004] United States patent application publication number US 2004/0021364 to Busley ("Busley"), discloses a construction machine for machining floor surfaces by rotating a work drum by use of an auxiliary drive motor. This auxiliary drive motor drives the drive train to rotate the work drum when the work drum is in a raised condition. The auxiliary drive in Busley is coupled to a drive belt or to an external surface of the motor-side pulley by means of a coupling unit.

[0005] The auxiliary drive of Busley is not without drawbacks. As an independent unit, the auxiliary drive must be coupled to the drive train. Therefore problems may arise due to failures in the coupling process, resulting in a failure to properly drive the work drum. Insufficient coupling of the auxiliary motor to the drive train can result in unwanted slippage which leads to unpredictable rotation of the work drum. This increases the time required for maintenance operations and reduces the time in which

the machine is available to operate properly, resulting in inefficient overall operation and increased cost. The present invention is directed to overcoming one or more of the problems as set forth above.

Summary of the Invention

[0006] The invention includes a chassis mounted to a drum rotor. A drive motor is also mounted to the chassis, and the drive motor may be coupled to a drive train that includes a drive pulley. The drive motor is capable of being adapted to drive the drive pulley. When the drive motor is activated, it drives the drive pulley to rotate the drum rotor at a first rotational velocity. The surface treatment machine may also include a service motor integral to the drive pulley. The service motor is capable of being adapted to drive the drive pulley to rotate the drum rotor at a second rotational velocity when the service motor is activated.

[0007] Also included is a method of manufacturing a surface treatment machine that includes providing a chassis with a drive motor mounted to the chassis. The method of manufacturing also includes coupling a drum rotor to the drive motor with a drive train that includes a drive pulley, and adapting the drive motor to the drive pulley to rotate the drum rotor at a first rotational velocity when the drive motor is activated. Further, the method includes integrating a service motor into the drive pulley, and adapting the service motor to the drive pulley to rotate the drum rotor at a second rotational velocity when the service motor is activated.

[0008] Other aspects and advantages of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, illustrating the principles of the invention by way of example only.

Brief Description of the Drawings

[0009] The foregoing and other objects, features, and advantages of the present invention, as well as the invention itself, will be more fully understood from the following description of various embodiments, when read together with the accompanying drawings, in which:

Fig. 1 is a diagram depicting a surface treatment machine in accordance with an embodiment of the invention;

Fig. 2 is a schematic diagram depicting the drive train in accordance with an embodiment of the invention; Fig. 3 is a partially exploded schematic diagram depicting the drive pulley and service motor in accordance with an embodiment of the invention;

Fig. 4 is a partially exploded schematic diagram depicting fastening means for integrating the service motor to the drive pulley in accordance with an embodiment of the invention;

Fig. 5 is a partially exploded schematic diagram

depicting the service motor and drive pulley in accordance with an embodiment of the invention;
 Fig. 6 is a diagram depicting the service motor connected to the drive pulley in accordance with an embodiment of the invention; and
 Fig. 7 is a flowchart depicting a method for manufacturing a surface treatment machine in accordance with an embodiment of the invention.

Detailed Description

[0010] As shown in the drawings for the purposes of illustration, the invention may be embodied in surface treatment machines including at least one drum rotor that may be dependably and precisely controlled for analysis and maintenance purposes, as well as methods of manufacturing, operating, and maintaining the same. These products and methods enable inspection and repairs by one or more operators. Embodiments of the invention may be implemented in surface treatment machines without increasing their overall footprint.

[0011] Reference will now be made in detail to embodiments of the invention, examples of which are illustrated in the accompanying drawings. Whenever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0012] In brief overview, Figure 1 is a profile view of a surface treatment machine 100 with the drum rotor and drive train visible. Surface treatment machine 100 is generally an industrial vehicle designed to engage a surface 105. Typically surface 105 is altered, rendered uniform, or otherwise treated upon engagement with surface treatment machine 100. Surface treatment machine 100 may include cold planer machines, milling machines, soil stabilizer machines, road reclaimer machines, surface mining machines, or other machines that include one or more drive systems. Surface 105 typically includes pavement, asphalt, concrete, soil, earth, stone, any form of road surface, or any combination of these and other similar materials.

[0013] Surface treatment machine 100 generally includes a chassis 110, which itself generally encompasses all frames, wheels, and machinery of surface treatment machine 100. Chassis 110 may be raised or lowered with respect to surface 105. Surface treatment machine 100 also generally includes a front tread 115 and a rear tread 120, which are both typically continuous metal belts in rolling contact with surface 105 as surface treatment machine 100 moves along surface 105. Front tread 115 and rear tread 120 may include any type of belt, tire, or wheel that provides sufficient traction to allow proper movement of surface treatment machine 100.

[0014] Drum rotor 125, which is typically a cylindrically shaped object, is generally located between front tread 115 and rear tread 120. The outer surface of drum rotor 125 generally contacts surface 105 during operation. This outer surface may be generally smooth, however according to other embodiments, drum rotor 125 may

include a coarse or uneven outer surface, and the outer surface may include protrusions or indentations of varying size or shape that are formed as part of its outer surface. Drum rotor 125 is capable of rotation and typically contacts surface 105 during normal operation. Even though, in the illustrative embodiment of Figure 1, drum rotor 125 is shown on top of surface 105, drum rotor 125 may be raised or lowered with respect to surface 105 so that it may penetrate beneath surface 105 to a depth sufficient to perform the desired treatment operations. Drum rotor 125 may be raised above surface 105 for inspection or maintenance purposes. In some embodiments, chassis 110 may be raised or lowered in order to raise or lower drum rotor 125 with respect to surface 105.

[0015] For example, when milling a paved road, drum rotor 125 may penetrate several inches or more (dozens of centimeters or more) below surface 105. During operation, surface treatment machine 100 is generally in forward motion over surface 105 with drum rotor 125 situated at a predetermined depth below surface 105. In this illustrative embodiment, drum rotor 125 is rotating and comes into contact with surface 105 as surface treatment machine 100 advances. This contact between drum rotor 125, which is rotating about its axis, advancing forward at the forward operating speed of surface treatment machine 100, and is submerged a predetermined depth below surface 105, is sufficient to pulverize the pavement to the predetermined depth.

[0016] To facilitate the pulverization of surface 105, or any other form of surface 105 treatment, drum rotor 125 may include a plurality of surface treatment tools 130. Surface treatment tools 130 are generally attachable and removable protrusions such as a plurality of teeth that extend from the outer surface of drum rotor 125. Surface treatment tools 130 may be placed randomly or in any pattern on the outer surface of drum rotor 125. For illustrative purposes, Figure 1 depicts surface treatment tools 130 extending uniformly around the entire outer surface of drum rotor 125. However, surface treatment tools 130 may cover all or only a portion of this outer surface, and may be differently shaped to protrude to varying distances and be spaced in varying patterns about the outer surface of drum rotor 125. Generally, surface treatment tools 130 engage surface 105 during operation to, for example, facilitate pavement milling or otherwise treat surface 105.

[0017] Drum rotor 125 is generally driven by a drive train that drives drum rotor 125 so that it rotates around its longitudinal axis. The drive train ordinarily includes at least one drive motor 135 shown schematically in Figure 1, at least one coupler 140, and at least one motor pulley 145. The drive train also generally includes a drive pulley 150, a service motor 155, and a belt 160. In an embodiment, drive motor 135 is operationally coupled by a coupler 140 to a motor pulley 145. In other embodiments, drive motor 135 may be coupled to any other components of the drive train, such as belt 160 for example. The drive train generally includes all of the components that enable

rotation of drum rotor 125. While depicted in Figure 1, drum rotor 125, surface treatment tools 130, drive motor 135, coupler 140, motor pulley 145, drive pulley 150, service motor 155, belt 160 and other drive train components such as a belt drive are generally within chassis 110 or protruding beneath surface 105, and thus are typically not visible externally. For example, these elements may be covered by a detachable panel that forms part of chassis 110.

[0018] Where drive motor 135 is in an active state (i.e., activated), it will drive belt 160, which in turn rotates drive pulley 150 and thus rotates rotor drum 125 at a first rotational velocity. The first rotational velocity of drum rotor 125 may vary, and is generally any rotational velocity sufficient for proper treatment of surface 105. For example, where surface treatment machine 110 is a cold planer machine performing a milling operation on surface 105, where surface 105 includes pavement, the first rotational velocity is generally a rotational velocity sufficient for drum rotor 125 to pulverize the pavement. In an embodiment, first rotational velocity is approximately 30rpm, however this rotational velocity can vary widely, for example, from a few to hundreds of revolutions per minute. Generally, when surface treatment machine 110 includes drum rotor 125 operating at a first rotational velocity, surface treatment machine 110 is in the process of treating a surface. In such a case, surface treatment machine 110 may be referred to as being in an operational state. The first rotational velocity is generally the rotational velocity of drum rotor 125 when it is being driven by drive motor 135, i.e. when drive motor 135 is activated.

[0019] When in an operational state, the first rotational velocity drum rotor 125 is generally not a suitable velocity to inspect or perform maintenance on drum rotor 125 of the surrounding area of surface treatment machine 110. Typically, the first rotational velocity is too high to use when inspecting or performing maintenance on drum rotor 125. Servicing drum rotor 125, for example to replace surface treatment tools 130 or to remove debris stuck between surface tools 130, is generally not possible at the first, or operational, rotating velocity. However, it is generally necessary to rotate drum rotor 125 for service or inspection purposes, as only a portion of drum rotor 125 is accessible at a given time. Using drive motor 135 to rotate drum rotor 125 for any non-operational purpose, such as for servicing, inspection, or maintenance would be difficult.

[0020] As stated above, surface treatment machine 110 generally includes service motor 155. Service motor 155 may be an electric motor, an induction motor, a hydraulic motor, or other device that converts electrical energy into mechanical energy or outputs mechanical energy. Service motor 155 is generally part of the drive train and provides the mechanical energy to rotate rotor drum 125 when service motor 155 is activated. When service motor 155 is active, it generally drives drum rotor 125 at a second rotational velocity. This second rotational velocity may also be referred to as a service rotational ve-

locity. The second rotational velocity is typically different than the first rotational velocity. Usually, the second, or service, rotational velocity is less than the first, or operational, rotational velocity. The second rotational velocity may vary, but for example may be less than 15rpm. In one embodiment, the second rotational velocity is approximately 3rpm. The second rotational velocity is generally sufficient to allow a service technician to inspect or perform maintenance operations on all or a portion of drum rotor 125 and the surrounding area.

[0021] The maximum output of service motor 155 may result in a maximum second rotational velocity that remains sufficient for the performance of inspection or maintenance operations. In this situation any unintended spike in service motor 155 power output is either not possible or would result in little or no increase in the second rotational velocity. Generally, the maximum power output of service motor 155 is sufficient only to overcome the inertia associated with drum rotor 125 and rotate drum rotor 125 at a constant but low speed relative to the first rotational velocity, such as for example 3rpm. However, the maximum power output is ultimately dependent on the desired functionality of service motor 155.

[0022] Service motor 155 may also be controlled by a service technician who is performing a service operation on or near drum rotor 125, to partially rotate drum rotor 125. For example, drum rotor 125 could be rotated at the second rotational velocity for 30 degrees, at which point service motor may be turned off, deactivated, or otherwise disengaged from the drive train so that drum rotor 125 stops rotating. At this time it may be possible to replace some of surface treatment tools 130 that are exposed to the service technician. After this replacement, service motor 155 could again be activated to rotate drum rotor at the second rotational velocity another 30 degrees before stopping again to enable inspection or replacement of another segment of surface treatment tools 130. In one embodiment, the amount drum rotor 125 is rotated may be determined by the operator while drum rotor 125 is being rotated. In one embodiment, the amount drum rotor 125 is rotated may be determined based on a predetermined rotational distance, time of rotation at a rotational velocity, or angle of rotation relative to the axis of drum rotor 125.

[0023] Generally, the motor whose power output is driving drum rotor 125 rotation at any point in time is the motor deemed to be activated. Typically, only one of drive motor 135 and service motor 155 is activated at any one time. In embodiments where both drive motor 135 and service motor 155 are producing a power output, typically only one of these motors is engaged with the drive train. In such a case the engaged motor is the activated motor and the power generated by the motor that is not engaged with the drive train does not effect drum rotor 125 rotation.

[0024] In various embodiments service motor 155 may be integral to or embedded within drive pulley 150. For example, drive pulley 150 may be cylindrical in shape and hollow, and service motor 155 may be located within

the inner diameter of drive pulley 150, or within a cylinder formed by the inner diameter of drive pulley 150 and extending along the longitudinal axis of drive pulley 150. For example, service motor 155 may be machined into or otherwise permanently affixed as an inseparable part of drive pulley 150 to form a single unit. In these embodiments, service motor 155 may directly engage either drum rotor 125 or the inner surface of drive pulley 150 in order to rotate drum rotor 125 at a second rotational velocity. This direct engagement ensures a reliable second rotational velocity and reduces power losses or drive train slippage associated with additional coupling mechanisms, which facilitates service operations. Additionally, in one embodiment, the addition of service motor 155 integral to drive pulley 150 does not change the overall footprint of surface treatment machine 105.

[0025] A service technician may manually engage and disengage a drive connection between service motor 155 and drum rotor 125. This may include connecting service motor 155 to a rotor input shaft of drum rotor 125. In one embodiment, service motor 155 may be connected to a rotor input shaft of drum rotor 125 by use of a freewheeling device. A freewheeling device generally allows for engagement and disengagement between service motor 155 and drum rotor 125 without manual service technician intervention. In one embodiment, the freewheeling device may also prohibit power output from service motor 155 or drive motor 135 from driving drum rotor 125 unless one of service motor 155 and drive motor 135 is activated. Furthermore, the freewheeling device may disengage service motor 155 to prevent it from transferring its mechanical power output to drum rotor 125 if that mechanical power output is higher than a predetermined threshold. This generally prevents the second rotational velocity of drum rotor 125 from exceeding a predetermined velocity, minimizing the chance of unpredicted changes in the second rotational velocity.

[0026] In situations where drive motor 135 is activated and drum rotor 125 is rotating at the first rotational (operational) velocity, the rotor input shaft of drum rotor 125 is typically rotating faster than it rotates in situations where service motor 155 is activated and drum rotor 125 is rotating at the second rotational (service) velocity. In embodiments where both drive motor 135 and service motor 155 are functioning and outputting power, the power output from drive motor 135 is generally greater than the power output from service motor 155. In this illustrative embodiment, the freewheeling device or a service technician operating manually, may disengage service motor 155 from drum rotor 125 so that only power from drive motor 135 is driving drum rotor 125 at the first operational velocity. Alternatively, the freewheeling device or a service technician operating manually, may disengage drive motor 135 so that only power from service motor 155 is used and drum rotor 125 is operating at the second rotational velocity. When drive motor 135 is activated, service motor 155 may be turned off. In this case, any residual power output from service motor 155 may

be disengaged from drum rotor 125 by the freewheeling device or a service technician.

[0027] Belt 160 is typically a flexible band that generally passes about at least motor pulley 145 and drive pulley 150 to transmit motion from drive motor 135 or service motor 155 to drum rotor 125. Belt 160 may include grooves to provide increased traction and prevent slippage when belt 160 contacts motor pulley 145 or drive pulley 160.

[0028] Surface treatment machine 100 may also include control panel 165. Control panel 165 generally controls operation of any drive train components such as service motor 155 to rotate drum rotor 125 at the second rotational velocity for inspection or servicing. Control panel 165 may also control operation of drive motor 135. Control panel 165 is typically located within chassis 110 in the vicinity of drum rotor 125 so that a service technician may operate any drive train components during servicing, or inspection. Alternatively, control panel 165 may be located on the external chassis 110 surface, remotely from surface treatment machine 100, or near operator cavity 170, which is the space where a human is normally positioned to operate surface treatment machine 100.

[0029] In brief overview, Figure 2 is a schematic diagram depicting a system 200 for the drive train in accordance with an embodiment of the invention. The drive train may generally include all components such as motors, pulleys and belts related to the driving of drum rotor 125. System 200 includes plate 205, which may be included as part of chassis 110 upon which drive motor 135 is mounted. System 200 includes drive motor 135, motor pulley 145, and drive pulley 150. Service motor 155 (not shown) may be integral to drive pulley 150.

[0030] System 200 also includes belt tensioning device 210. Belt tensioning device 210 may include a pneumatic or hydraulic pump, motor, or other mechanical device designed to maintain a desired tension in belt 160 (not shown) where belt 160 is generally looped around motor pulley 145, drive pulley 150, and belt tensioning device 210. Belt 160 is typically operationally coupled to motor pulley 145, drive pulley 150, and belt tensioning device 210 so that belt 160 circulates when any of motor pulley 145, drive pulley 150, belt 160, or belt tensioning device 210 are rotationally driven.

[0031] In system 200, panel 215 typically surrounds the drive train in general, and more specifically may laterally surround belt 160. In various embodiments, panel 215 may be considered part of plate 205 or chassis 110. Panel 215 generally acts to prevent debris from interfering with the function of any of the drive train components, such as belt 160, drive pulley 150, service motor 155, motor pulley 145, coupler 140, or drive motor 135, for example.

[0032] The entirety of system 200 may be covered by a cover plate (not shown). A cover plate, along with plate 205 and panel 215 may be part of chassis 110 and typically shields the entire drive train from external view, thus reducing exposure to debris and other elements

such as rain. Plate 205 and panel 215 may be detachable or otherwise removable from surface treatment machine 100 to facilitate access to drive train components.

[0033] Figure 3 in brief overview is a partially exploded schematic diagram depicting a system 300 for drive pulley 150 and service motor 155 in accordance with an embodiment of the invention. As can be seen, system 300 depicts plate 205 and panel 215 both generally shielding the drive train from harm and acting to mount various drive train components, such as drive pulley 150 for example, to the chassis. System 300 generally depicts an embodiment where service motor 155 is integral to drive pulley 150. In this illustrative embodiment, service motor 155 is directly fastened to the inner diameter of drive pulley 150 by flange 305. Flange 305 may include fastening means such as bolts 310, screws, adhesives, clips, or rivets, for example. Flange 305 generally integrates service motor 155 with drive pulley 150. Service motor 155 rotation may directly drive drive pulley 150. Flange 305 may include a shaft 315. In one embodiment shaft 315 may act as the previously described input shaft of the drum rotor. In various embodiments, mechanical output of service motor 155 rotates shaft 315 which in turn causes drive pulley 150 to rotate. In some embodiments, flange 305 may rotate with shaft 315. In this illustrative embodiment, fastening means such as bolts 310 connect service motor 155 to flange 305 and drive pulley 150 to rotationally drive drive pulley 150 when service motor 155 is activated.

[0034] Figure 4 is a partially exploded schematic diagram depicting a system 400 using fastening means for integrating service motor 155 with drive pulley 150 in accordance with an embodiment of the invention. As can be seen in this illustrative embodiment, fastening means integrates service motor 155 (not shown) with drive pulley 150 and generally includes a plurality of bolts 310 that secure flange 305 to the inner diameter of drive pulley 150. Within flange 305 typically lies wheel assembly 405 and bushing 410, both of which in combination generally act to rotationally couple shaft 315 to drive pulley 150. Referring back to Figure 3, shaft 315 is also rotationally coupled to service motor 155 such that mechanical output from service motor 155 generally causes shaft 315 to spin about its longitudinal axis. Flange 305, wheel assembly 405, and bushing 410 generally transfer this rotational force to drive pulley 150, which is coupled by fastening means, such as bolts 415, (or alternatively screws, clamps, rivets, pin locks, adhesives or the like) to drum rotor 125. In this illustrative embodiment fastening means, which may include flange 305, wheel assembly 405, bushing 410, bolts 310, and shaft 315 combine to accommodate service motor 155 within a cylinder formed by the interior diameter of drive pulley 150 and extending along the longitudinal axis of drive pulley 150. In this way, service motor 155 directly drives the drive pulley 150/drum rotor 125 assembly, and this integration between service motor 155 and drive pulley 150 prevents unintended slippage or other errors due to intervening

linkage elements such as friction rotors malfunctioning and failing to properly drive drive pulley 150.

[0035] Figure 5 is a partially exploded schematic diagram depicting a system 500 of the service motor and drive pulley in accordance with an embodiment of the invention. In this illustrative embodiment, service motor 155 is aligned for integration within the inner diameter of drive pulley 150. In various embodiments, service motor 155 may be integrated into drive pulley 150 by fastening means that include securing fastening plate 505 to service motor 155 and to plate 205 with mounting plate 510 and fasteners 515. Fasteners 515 may include bolts, screws, adhesive, clamps, rivets, pin locks, or the like. Fastening plate 505 may be secured to service motor 155 by fastening means such as bolts 520, or alternatively screws, adhesive, clamps, rivets, pin locks, or other similar means. In the embodiment illustrated by Figure 5, service motor 155 is integrated within the inner diameter of drive pulley 150.

[0036] Figure 6 is a diagram depicting a system 600 where service motor is connected to drive pulley 150 in accordance with an embodiment of the invention. In this illustrative embodiment, service motor 155 is integrated into and contained within a cylinder formed by the inner diameter of drive pulley 150 and extending along the longitudinal axes of drive pulley 150. Service motor 155 may be secured by fastening means including fastening plate 505 and mounting plate 510. The outer diameter surface of drive pulley 150 may include a plurality of ridges 605. Ridges 605 generally align with corresponding ridges in belt 160 (not shown) to provide better traction and reduce slippage when belt 160 and drive pulley 150 are rotating.

[0037] Any references to front and back, left and right, top and bottom, upper and lower, and forward and backward, are intended for convenience of description, not to limit the present invention or its components to any one positional or spacial orientation.

Industrial Applicability

[0038] From the foregoing, it will be appreciated that surface treatment machine 100 is capable of industrial application. During use, surface treatment machine 100 affords a simple and effective way to treat surface 105. For example, surface treatment machine 100 may function as a cold planer machine, which generally treats surface 105 to remove worn or deteriorated pavement to a predetermined grade and slope, and leaves a textured surface that may be opened immediately to traffic or overlaid with new pavement, such as asphalt. Surface treatment machine 100 may also function as a soil stabilizer, which generally treats surface 105 by cutting, mixing, and pulverizing native in-place soils with additives or aggregates to modify and stabilize the soil to a predetermined depth to provide a strong base. Further, surface treatment machine 100 may include a road reclaimer, which generally pulverizes an asphalt layer to a predetermined depth and mixes it with the underlying base to stabilize

deteriorated roadways. Road reclaimers may also add asphalt emulsions or other agents, such as binding agents, during pulverization or during a separate pass over surface 105. Generally, surface treatment machine 100 possesses industrial applicability in any machine with one or more drive systems such as a drive pulley apparatus.

[0039] Surface treatment machine is generally operated by an operator who activates drive motor 135 to rotate the drum rotor 125 at the first rotational velocity (i.e., the operational velocity), in order to treat surface 105 by, for example, pulverizing surface 105 to a depth of 12 inches (38 centimeters). At this time, surface treatment machine 100 may be said to be in an operational state. When in an operational state, surface treatment machine 100 is generally in motion relative to surface 105.

[0040] When, for example, debris such as pulverized pavement interferes with this operation, or when surface treatment tools 130 become worn, the operator may control surface treatment machine 100 so that service motor 155 is activated and drum rotor 125 rotates at the second rotational velocity (i.e., the service velocity) so that drum rotor 125 may be inspected or repaired by the operator or any person acting as a service technician. At this time, surface treatment machine 100 may be said to be in a service state. In this illustrative embodiment, service motor 155 may be integral to drive pulley 150.

[0041] Typically, only one of service motor 155 and drive motor 135 is activated at a given time. Generally, a motor is activated when its power output is being used to drive drum rotor 125. In embodiments where both service motor 155 and drive motor 135 are outputting power simultaneously, typically only the power output from one of these two motors is engaged with or coupled to the drive train (i.e., activated) so that only one of these two motors is driving drum rotor 125 at any one time. For example, if drive motor 135 is driving drum rotor 125 at the first rotational velocity, service motor 155 may be disengaged from the drive train so that any power output from service motor 155 is not transferred through the drive train to drum rotor 125.

[0042] In brief overview, Figure 7 is a flowchart depicting a method 700 for manufacturing a surface treatment machine in accordance with an embodiment of the invention. Method 700 may be suitable for an assembly line or high volume manufacture, assembly, or production of a surface treatment machine, as well as low volume or individual customized manufacture of a single machine.

[0043] Method 700 generally includes the step of providing a chassis with a drive motor mounted to the chassis (STEP 705). This providing step (STEP 705) may include manufacturing a chassis and drive motor from their fundamental base parts, or it may include making these components available for the rest of the manufacturing process method 700. Method 700 proceeds by coupling a drum rotor to the drive motor with a drive train that includes a drive pulley (STEP 710). This coupling step

(STEP 710) includes electrically or mechanically joining, fastening, or associating the drum rotor to the drive motor. This may include fastening means such as nuts, bolts, screws, clamps, pin locks, friction fits, pressure fits, or adhesives, for example.

[0044] Method 700 generally continues by adapting the drive motor to the drive pulley to rotate the drum rotor at a first rotational velocity when the drive motor is activated (STEP 715). This adapting step (STEP 715) typically includes engaging the drive motor with the drive train so that the power output of the drive motor is used to rotate the drum rotor at a first rotational velocity when the drive motor is activated. Adapting (STEP 715) the drive motor may include coupling the drive motor to any component of the drive train, such as a belt or a motor pulley.

[0045] Method 700 may also integrate a service motor into the drive pulley (STEP 720). Integrating step (STEP 720) may include affixing a service motor inside the inner diameter of the drive pulley so that the service motor and the drive pulley may in some embodiments form a single inseparable unit so that the service motor, when activated, directly drives the drive pulley. Alternately, the service motor may directly drive the drum rotor. In various embodiments integrating a service motor into the drive pulley (STEP 720) may include fastening a service motor to any portion of the drive pulley, or within a cylinder whose diameter corresponds to the cylinder formed by the inner diameter of the drive pulley and extends along the longitudinal axis of the drive pulley, with or without intervening coupling elements, such as bolts or fasteners so that service motor, when activated, effects drum rotor rotation in a controlled manner.

[0046] Method 700 also generally includes the step of adapting the service motor to drive the drive pulley to rotate the drum rotor at a second rotational velocity when the service motor is activated (STEP 725). Typically when the service motor is activated the drive motor is not activated. Adapting step (STEP 725) typically includes engaging the service motor with the drive train so that the power output of the service motor is used to rotate the drum rotor at a second rotational velocity when the service motor is activated. Adapting (STEP 725) the drive motor may include an operator such as a service technician manually engaging the service motor with an input shaft of the drum rotor. Alternatively, adapting (STEP 725) may include connecting the service motor with an input shaft of the drum rotor (STEP 730). Connecting step (STEP 730) may be accomplished by use of a free-wheeling device. In various embodiments, both adapting step (STEP 725) and connecting step (STEP 730) may include engaging the service motor to any component of the drive train, such as a belt or a motor pulley by means of any of a fasteners, clips, nuts, bolts, screws, clamps, pin locks, friction, pressure, or an adhesive.

[0047] In some embodiments, method 700 may also include providing a control panel (STEP 735) enabling a user, such as an operator, to activate at least one of the

drive motor and the service motor to operate the surface treatment machine at one of the first rotational velocity and the second rotational velocity. In this illustrative embodiment, it is specifically the drum rotor that is rotating at one of the first rotational velocity and the second rotational velocity. Method 700 may also include fastening the control panel to the chassis (STEP 740). Fastening step (STEP 740) typically includes fastening by any means previously described as fastening means, such as bolts, rivets, screws, pin locks, or various adhesives for example.

[0048] Method 700 may also include providing a plurality of surface treatment tools (STEP 745) capable of attachment to the drum rotor. Providing the surface treatment tools (STEP 745) may include manufacturing or assembling the surface treatment tools from raw materials, or otherwise making surface treatment tools available to the surface treatment machine.

[0049] Where technical features mentioned in any claim are followed by reference signs, the reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, neither the reference signs nor their absence have any limiting effect on the technical features as described above or on the scope of any claim elements.

[0050] One skilled in the art will realize the invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The foregoing embodiments are therefore to be considered in all respects illustrative rather than limiting of the invention described herein. Scope of the invention is thus indicated by the appended claims, rather than the foregoing description, and all changes that come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

Claims

1. A surface treatment machine (100), comprising:

a chassis (110);
 a drum rotor (125) mounted to the chassis (110);
 a drive motor (135) mounted to the chassis (110), the drive motor (135) being coupled to a drive train that includes a drive pulley (150);
 the drive motor (135) being adapted to drive the drive pulley (150) to rotate the drum rotor (125) at a first rotational velocity when the drive motor (135) is activated; and
 a service motor (155) adapted to drive the drive pulley (150) to rotate the drum rotor (125) at a second rotational velocity when the service motor (155) is activated;
characterized in that
 the service motor (155) being integral to the drive pulley (150) within an inner diameter of the drive pulley (135) and being connected to an

input shaft (315) of the drum rotor (125) by a freewheeling device adapted to reversibly engage the service motor (155) with the drum rotor (125).

2. The surface treatment machine according to claim 1, including:

a plurality of surface treatment tools (130) fastened to the drum rotor.

3. The surface treatment machine according to claim 1, including:

a control panel (165) accessible by an operator adapted to activate at least one of the drive motor and the service motor.

4. The surface treatment machine according to claim 1 wherein the service motor is integral to the drive pulley within an inner diameter of the drive pulley.

5. The surface treatment machine according to claim 4 wherein a fastening plate (505) secured both to the service motor and to a mounting plate (510) integrates the service motor to the drive pulley.

6. The surface treatment machine according to claim 1 wherein the service motor is located within a cylinder formed by an inner diameter of the drive pulley and extending along the longitudinal axis of the drive pulley.

7. The surface treatment machine according to claim 1 wherein at least one of the service motor and the drive motor is activated.

8. The surface treatment machine according to claim 1 wherein the drive train includes a belt (160).

9. The surface treatment machine according to claim 1 wherein the service motor includes a hydraulic motor.

10. The surface treatment machine according to claim 1 wherein the first rotational velocity is greater than 30 revolutions per minute.

11. The surface treatment machine according to claim 1 wherein the second rotational velocity is less than 15 revolutions per minute.

12. The surface treatment machine according to claim 1 wherein the second rotational velocity is less than the first rotational velocity.

13. The surface treatment machine according to claim 1 wherein the surface treatment machine is selected

from the group consisting of a cold planer, a milling machine, a soil stabilizer, road reclaimer, and a surface miner.

14. A method of manufacturing a surface treatment machine (100), comprising: 5

providing a chassis (110) with a drive motor (135) mounted to the chassis (110);
coupling a drum rotor (125) to the drive motor (135) with a drive train that includes a drive pulley (150); 10
adapting the drive motor (135) to drive the drive pulley (150) to rotate the drum rotor (125) at a first rotational velocity when the drive motor (135) is activated; 15
providing a service motor (155); and
adapting the service motor (155) to drive the drive pulley (150) to rotate the drum rotor (125) at a second rotational velocity when the service motor (155) is activated; 20
characterized in the steps of
integrating the service motor (155) within the inner diameter of the drive pulley (135), and and
connecting the service motor (155) to an input shaft (315) of the drum rotor (125) by a free-wheeling device adapted to reversibly engage the service motor (155) with the drum rotor (125). 25

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15. The method according to claim 14, including:

providing a control panel (165) enabling a user to activate one of the drive motor and the service motor to rotate the drum rotor at one of the first rotational velocity and the second rotational velocity. 35

16. The method according to claim 15, including:

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fastening the control panel to the chassis.

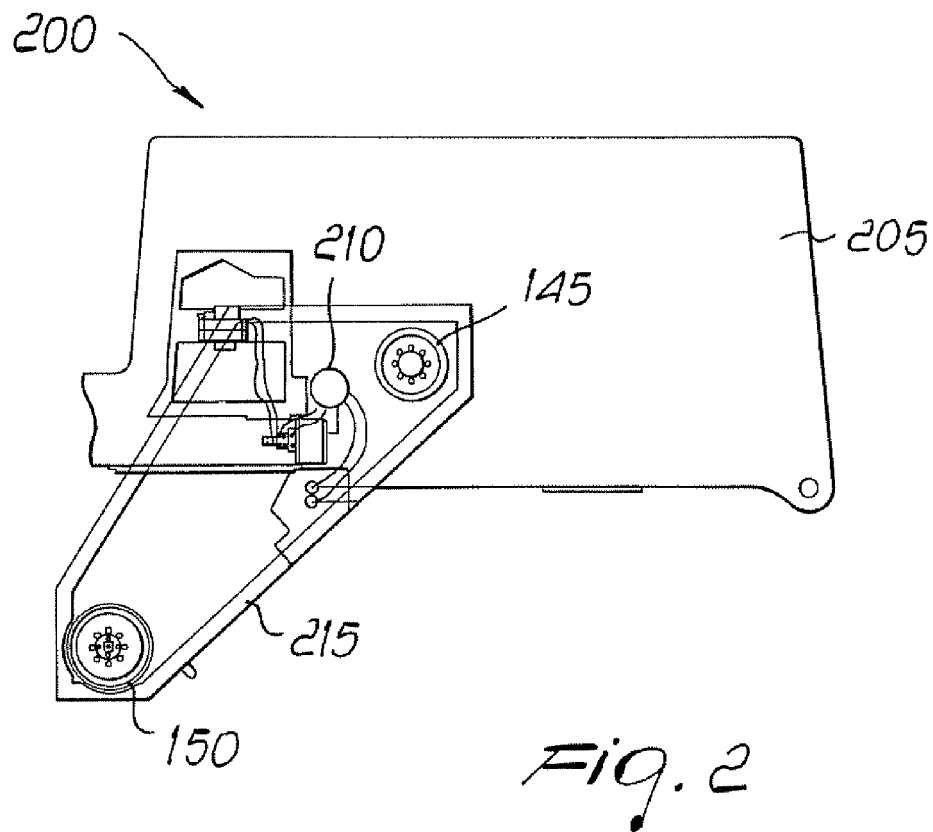
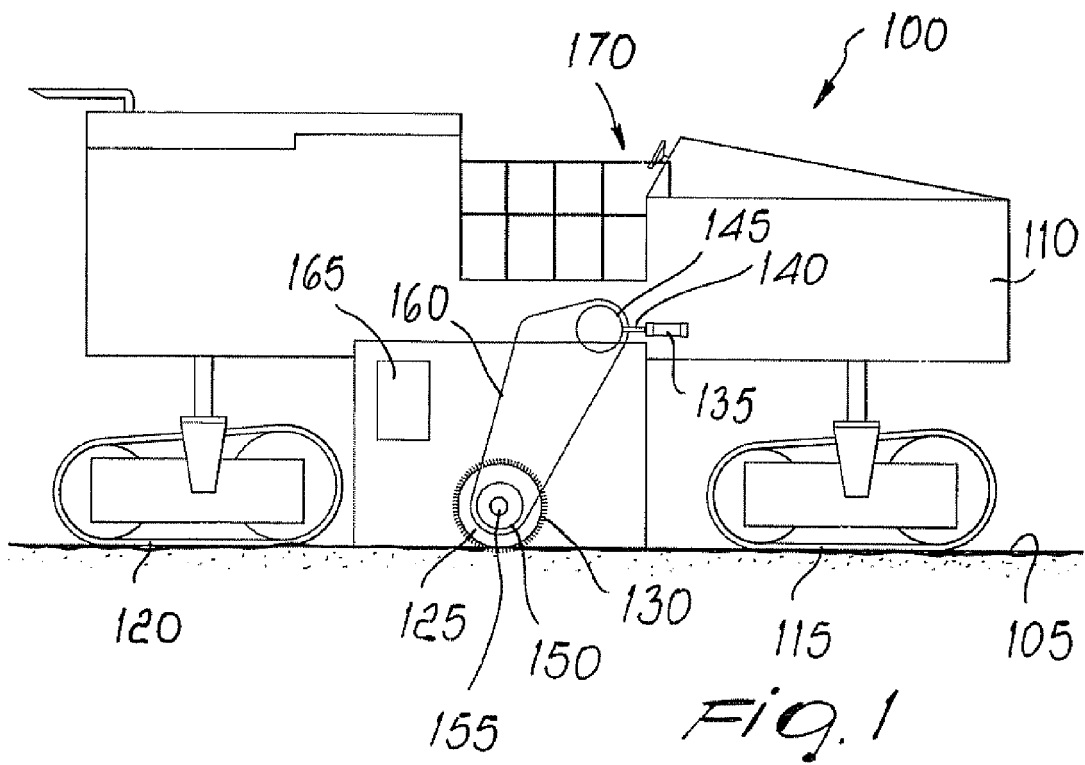
17. The method according to claim 14, including:

providing a plurality of surface treatment tools (130) capable of attachment to the drum rotor. 45

18. The method according to claim 14 wherein integrating the service motor within the inner diameter of the drive pulley includes securing a fastening plate (505) both to the service motor and to a mounting plate (510). 50

19. The method according to claim 14 wherein integrating the service motor into the drive pulley includes locating the service motor within a cylinder formed by an inner diameter of the drive pulley and extending along the longitudinal axis of the drive pulley. 55

20. The method according to claim 14 wherein the second rotational velocity is less than the first rotational velocity.



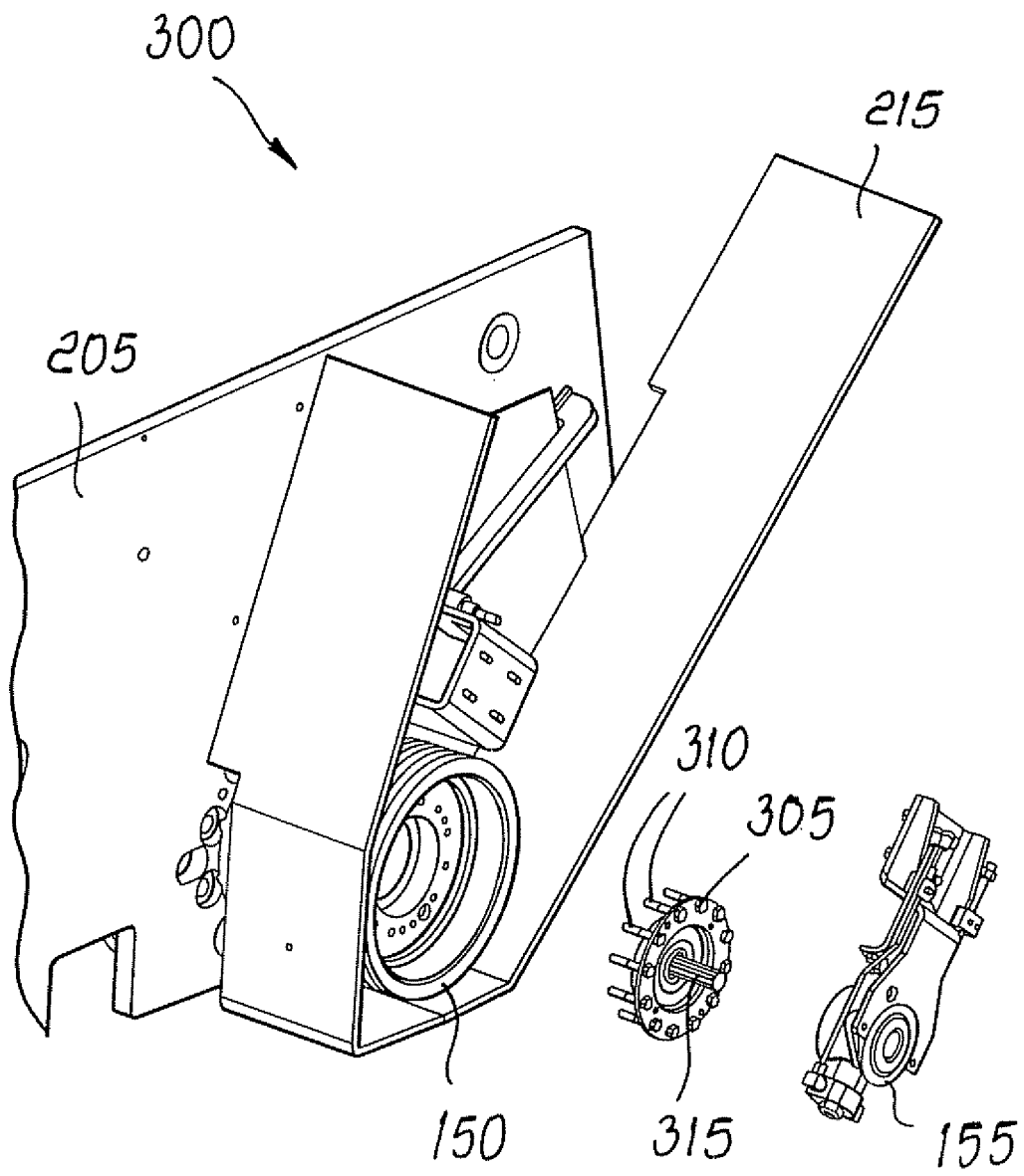
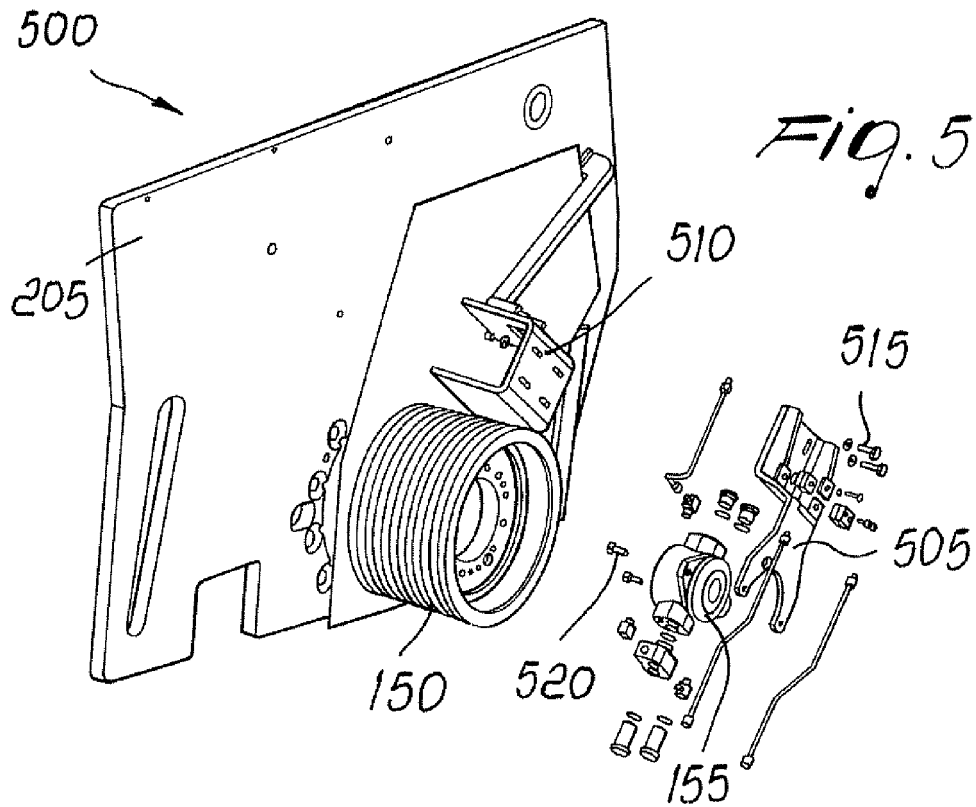
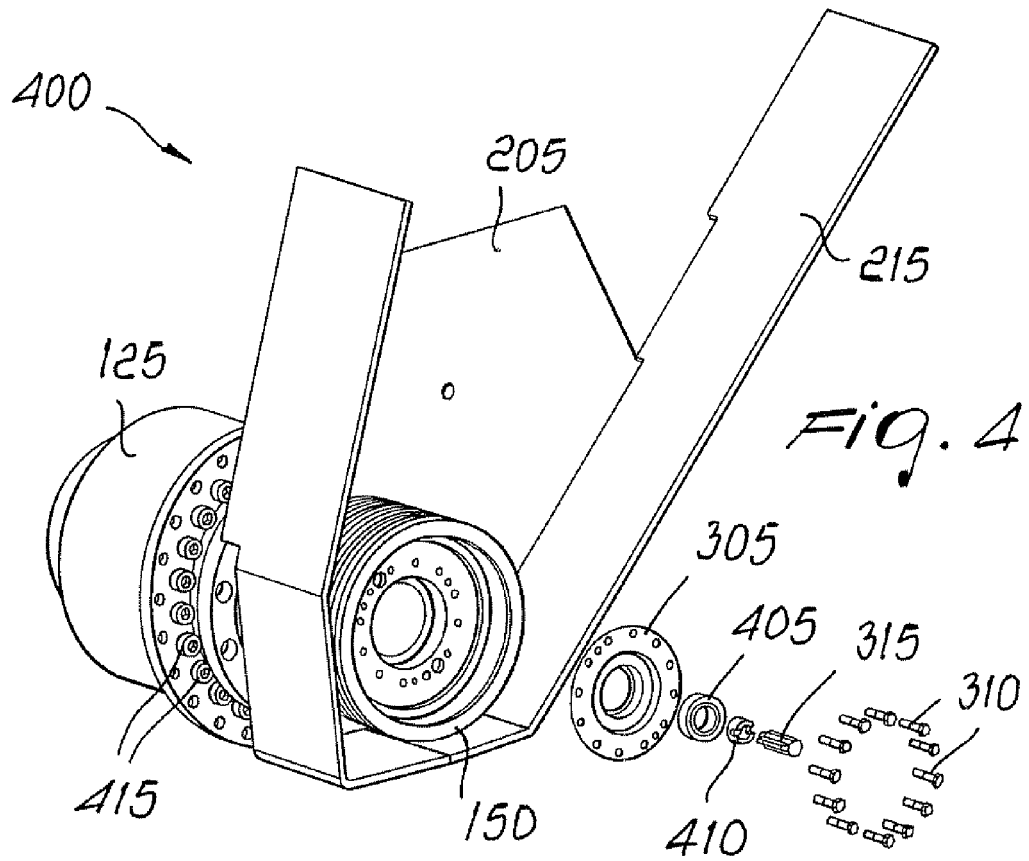


Fig. 3



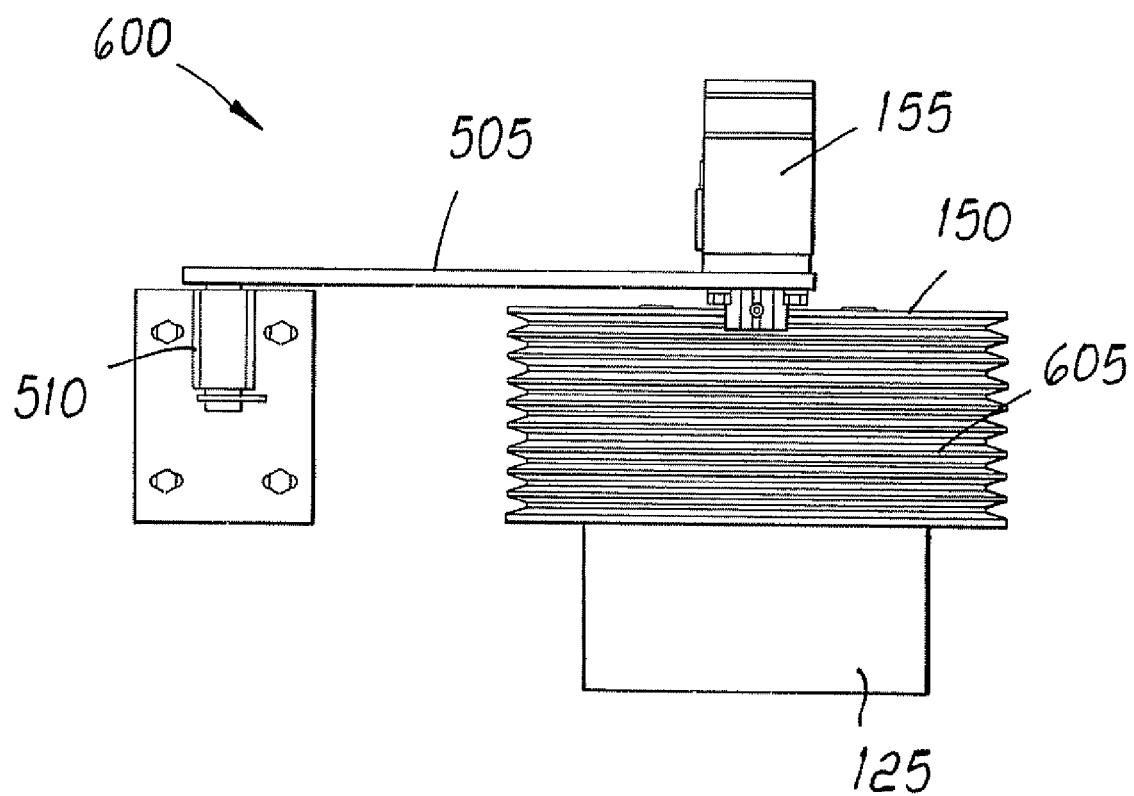


Fig. 6

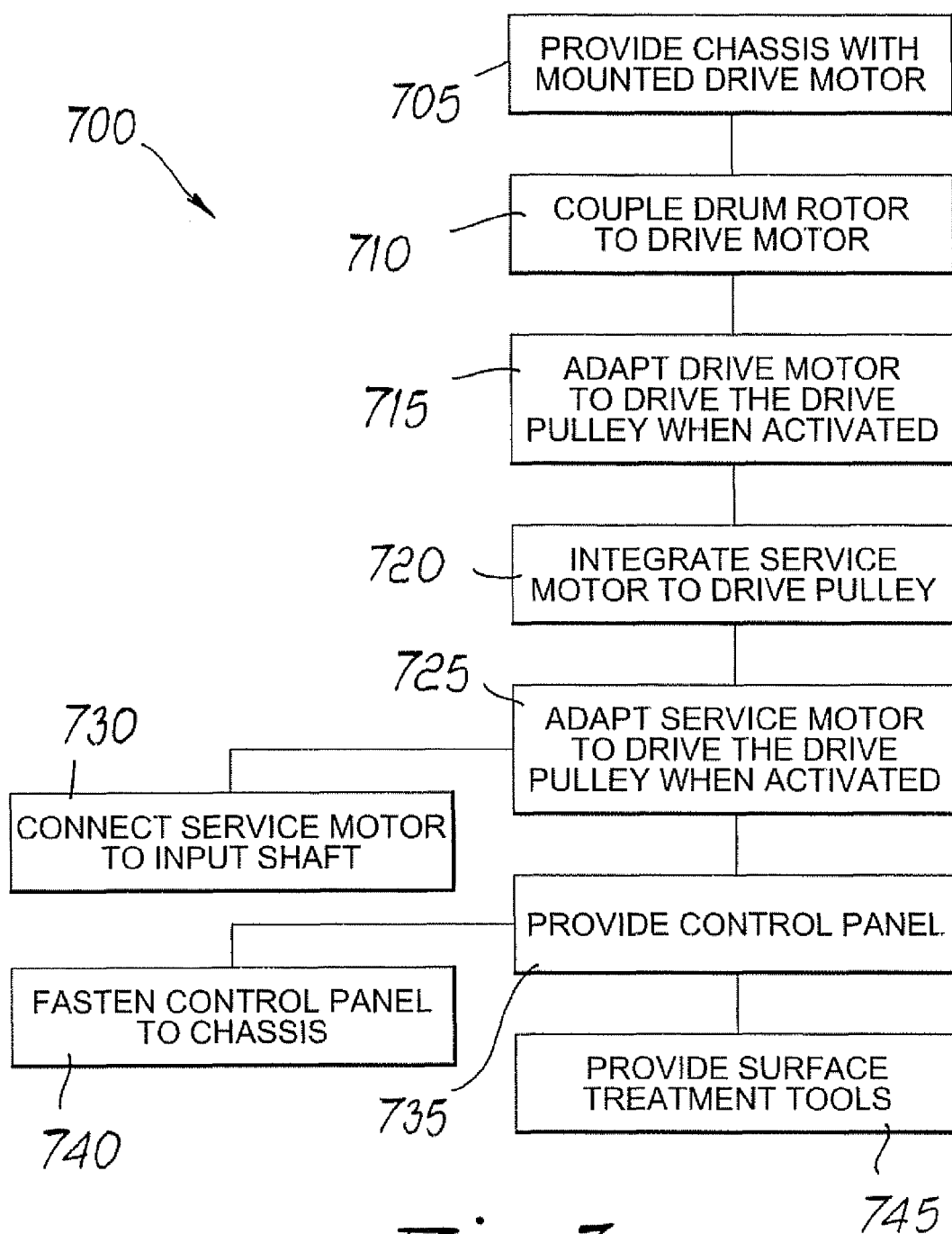


Fig. 7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 20040021364 A, Busley [0004]