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(54) Title: COMBINED MOTOR GRADER STEERING AND CONTROL SYSTEM

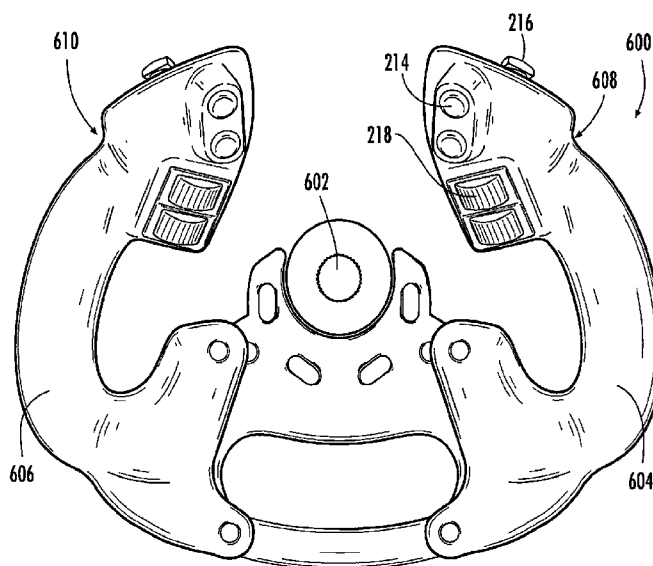


FIG. 6B

(57) Abstract: Combined steering and control system for a construction vehicle. A plurality of control switches are arranged on a steering device, which has a limited range of rotation. The control switches communicate with work tool actuators, which control and move the work tool as directed. An operator manipulates control switches to direct the motion and position of a work tool. As the steering device is displaced from its neutral position, a steering signal is generated to indicate a wheel angle. A steering controller generates a steering control signal responsive to road speed, road wheel angle and steering wheel angle, to cause steerable road wheels turned at a requested road wheel angle. The ratio of requested road wheel angle to steering wheel angle defines a steering scale ratio. Varying the steering scale ratio with road speed and road wheel angle permits full turn of road wheels despite the limited range of rotation.



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AMENDED CLAIMS
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1. A combined steering and control system of a construction vehicle carried by road wheels, at least one of said road wheels being steerable, said construction vehicle having a work tool, said work tool being movable relative to said construction vehicle, motion and positioning of said work tool being controlled by work tool actuators, the system comprising:

a steering device, displacement of said steering device from a neutral position generating a steering input signal to indicate a steering wheel angle, said displacement being limited within a range;

said steering device having an elongated hand grip region, an upper face and a lower face;

a plurality of control switches positioned adjacent said hand grip region, said plurality of control switches moving conjointly with said steering device when said steering device is being displaced from said neutral position, each of said plurality of control switches being actuatable to generate a control signal for controlling operation of at least one of said work tool actuators;

a road wheel angle sensor for detecting road wheel angle of said at least one steerable road wheel; and

a steering controller communicating with said steering device and said road wheel angle sensor, said steering controller generating a steering control signal responsive to said steering input signal, said steering control signal causing said at least one steerable road wheel to be turned to a requested turned angle;

wherein a ratio of said requested turned angle to said steering wheel angle defines a steering scale ratio, wherein said steering scale ratio varies with said road speed of said construction vehicle and said road wheel angle, and wherein said steering controller generates said steering control signal according to a function describing said steering scale ratio.

2. The system of claim 0, wherein said steering device is rotatably mounted to the construction vehicle, rotation of said steering device producing said steering input signal.

3. The system of claim 0, wherein said displacement is angular and measured by a steering wheel angle of said angular displacement of said steering device from its neutral position, said steering device further comprising a steering wheel angle sensor to detect said steering wheel angle.
4. The system of claim 0, wherein said steering wheel angle is limited to a maximum of 90°.
5. The system of claim 0, wherein said steering wheel angle is limited to a maximum of 50°.
6. The system of claim 0, wherein said elongated handgrip region has a thumb end.
7. The system of claim 0, wherein said plurality of control switches include at least one control switch arranged on said upper face adjacent said thumb end, said at least one control switch generating its control signal responsive to manipulation of said one control switch in a direction generally along the length of the elongated hand grip region.
8. The system of claim 0, wherein said plurality of control switches include at least one control switch arranged on said lower face adjacent said thumb end, said at least one control switch generating its control signal responsive to manipulation of said one control switch in a direction generally transverse to the elongated hand grip region.
9. The system of claim 0, wherein said plurality of control switches include at least one two-way switch positioned on the upper face adjacent said thumb end.
10. The system of claim 0, wherein said steering device includes a central panel region.
11. The system of claim 0, further comprising a display control disposed in said central panel region.
12. The system of claim 0, wherein at least one of said plurality of control switches is disposed in said central panel region.
13. The system of claim **Error! Reference source not found.**, wherein said variable steering scale ratio increases with said road wheel angle.

14. The system of claim 1, wherein said variable steering scale ratio decreases with said road speed.
15. The system of claim 14, wherein said variable steering scale ratio increases with said road wheel angle.
16. The system of claim 0, wherein said steering scale ratio remains constant with respect to at least one of road speed of said construction vehicle and said road wheel angle,
17. The system of claim 1, wherein said elongated hand grip region includes a left hand grip region and a right hand grip region.
18. A combined steering and control system of a construction vehicle carried by road wheels, at least one of said road wheels being steerable by a hydraulic cylinder controlled by a hydraulic valve, said construction vehicle having a work tool, said work tool being movable relative to said construction vehicle, motion and positioning of said work tool being controlled by work tool actuators, the system comprising:
- a steering device, displacement of said steering device from a neutral position generating a steering input signal to indicate a steering wheel angle, said displacement being limited within a range;
 - said steering device having an elongated hand grip region;
 - a plurality of control switches positioned adjacent said hand grip region, said plurality of control switches moving conjointly with said steering device when said steering device is being displaced from said neutral position, each of said plurality of control switches being actuatable to generate a control signal for controlling operation of at least one of said work tool actuators;
 - a road wheel angle sensor for detecting road wheel angle of said at least one steerable road wheel; and
 - a steering controller, said steering controller being in communication with said steering device, said road wheel angle sensor and said hydraulic valve, said steering controller generating a steering control signal responsive to said steering input signal, said steering control signal actuating said hydraulic valve to control said

hydraulic cylinder to steer said at least one steerable road wheel to a requested turned angle;

wherein a ratio of said requested turned angle to said steering wheel angle defines a steering scale ratio, wherein said steering scale ratio varies with road speed of said construction vehicle and said road wheel angle, and wherein said steering controller generates said steering control signal according to a function describing said steering scale ratio.

19. The system of claim 18, wherein said steering controller further comprises a steering angle module and a ground speed module, said steering angle module being in communication with said steering device to receive said steering input signal and said ground speed module being in communication with a speed measurement device to receive a signal representing road speed of the vehicle, said steering angle module and said ground speed module scaling said steering input signal according to said steering scale ratio to obtain a value of said requested turned angle.

20. The system of claim 18, wherein said variable steering scale ratio increases with said road wheel angle.

21. The system of claim 18, wherein said variable steering scale ratio decreases with said road speed,

22. The system of claim 0, wherein said steering controller is configured to modify the steering control signal for dead-band compensation prior to applying said steering control signal to the hydraulic valve.

23. The system of claim 0, wherein said steering controller further comprises an enable switch, said enable switch disconnecting said steering controller from said hydraulic valve upon detection of a pre-selected trigger condition.

24. The system of claim 0, further comprising an on/off valve, said on/off valve being controllable by said steering controller to interrupt fluid communication between said hydraulic valve and said hydraulic cylinder upon detection of a pre-selected trigger condition.

25. The system of claim 0, wherein said displacement is angular and measured by a steering wheel angle of said angular displacement of said steering device from its neutral position, said steering device further comprising a steering wheel angle sensor to detect said steering wheel angle.
26. The system of claim 25, wherein said steering wheel angle is limited to a maximum of 90°.
27. The system of claim 25, wherein said steering wheel angle is limited to a maximum of 50°.

STATEMENT UNDER ARTICLE 19 (1)

This Statement Under Article 19(1) accompanies an amendment under Article 19 filed on even date.

Claims 1 and 18 have been amended to recite that the steering scale ratio varies with said road speed of said construction vehicle and said road wheel angle. The invention defined by independent claims 1 and 18 is not disclosed or suggested by the art cited in the Search Report

In the Search Report and Written Opinion, US Patent Application Publication No. US2005/0199436 to Shroder et al. was cited against claims 1 and 19 (now claim 18). The Shroder publication, as noted by the Examiner, discloses adjusting a steering ratio according to speed, but fails to disclosing using road wheel angle.

US Patent Application Publication No. US2006/76741 to Lim was cited as disclosing (at paragraphs 065-0067) a variable steering ration adjusted for road wheel angle. However, Lira does not disclose this subject matter. Lim, to the contrary, discloses adjusting a vehicle suspension to compensate for vehicle tilt during steering. There is nothing in Lim that relates to adjusting a steering wheel ratio.

As the art cited in the International Search and Written Opinion does not show or suggest the invention, the claims are submitted to be patentable.