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[54] **MINIATURE JOYSTICK MOUNTED ON A JOYSTICK**

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[51] **Int. Cl.**[6] **B60K 26/00**

[52] **U.S. Cl.** ..... **180/333**; 74/471 XY

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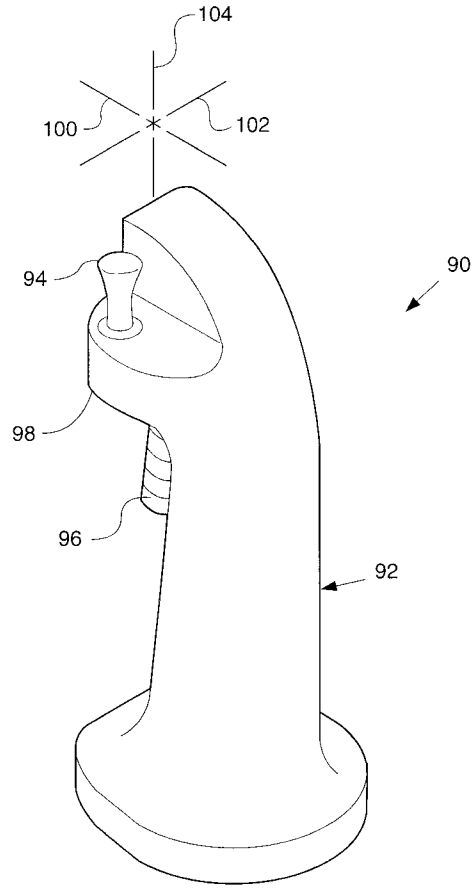
[57] **ABSTRACT**

A hand-operated dual joystick for a motor grader is disclosed. The dual joystick comprises a first joystick having a ledge and a switch, and a second joystick that is significantly smaller than the first joystick. The second joystick is mounted to the ledge of the first joystick. The first joystick is moveable along a first axis and a second axis that are perpendicular to each other. In addition, the first joystick is rotatable about a third axis that is perpendicular to the first axis and to the second axis. The second joystick is moveable along the first axis and the second axis. Movement of the first joystick and the second joystick is used to control a plurality of motor grader functions. The dual function joystick permits an operator to control a plurality of the motor grader functions from a single location thus reducing operator fatigue.

10 Claims, 4 Drawing Sheets



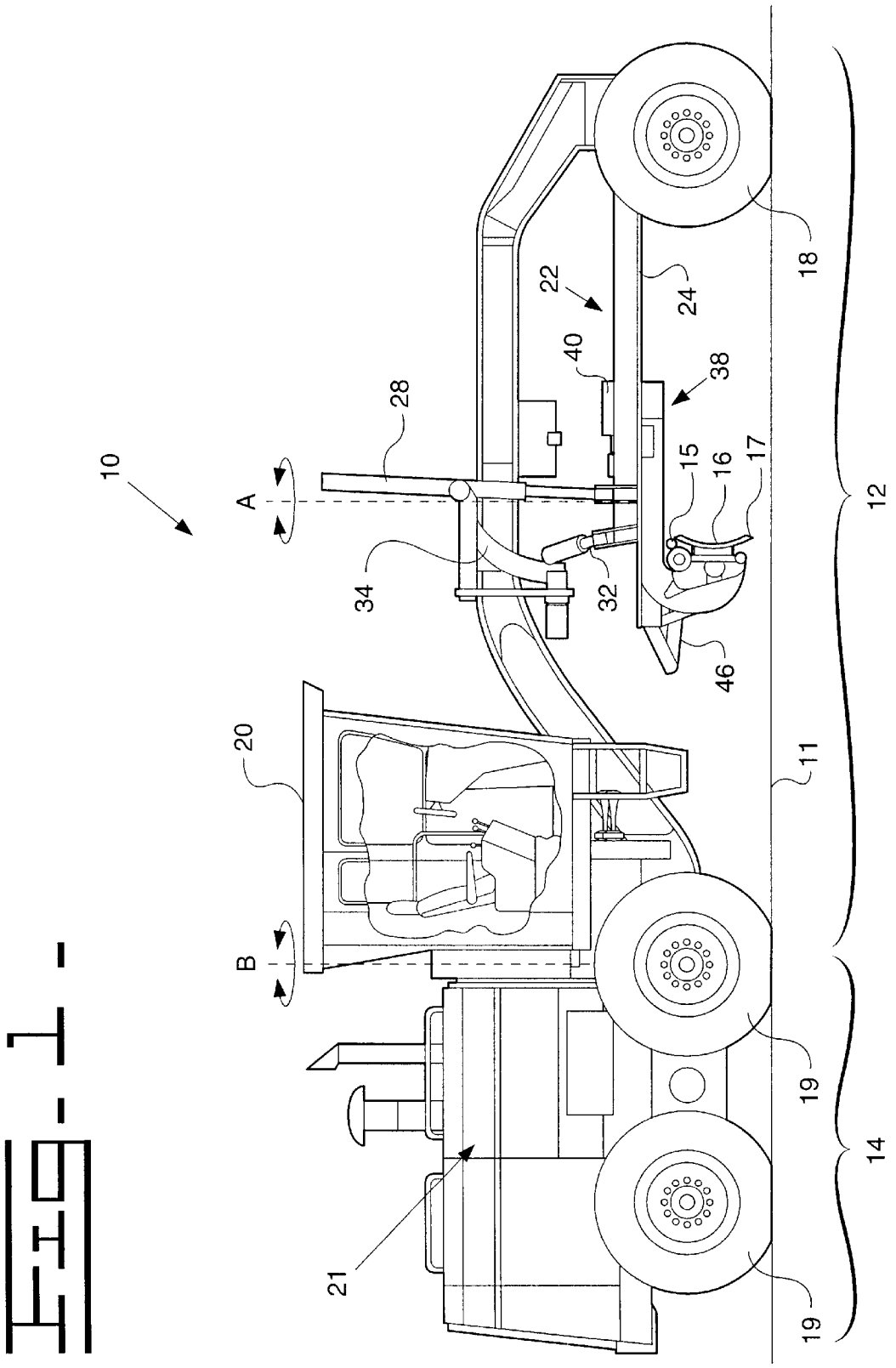


FIG. 1

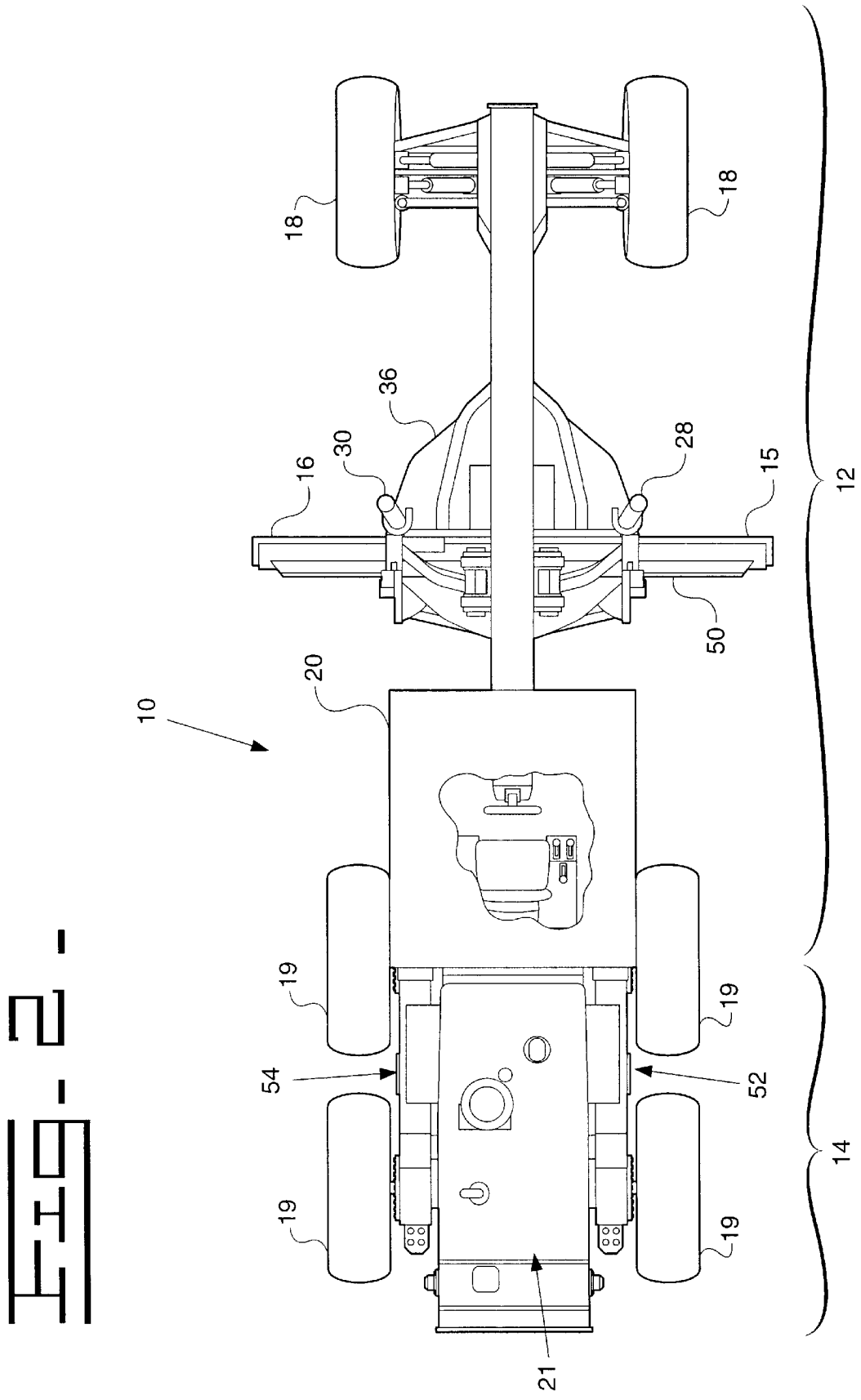


Fig. 2

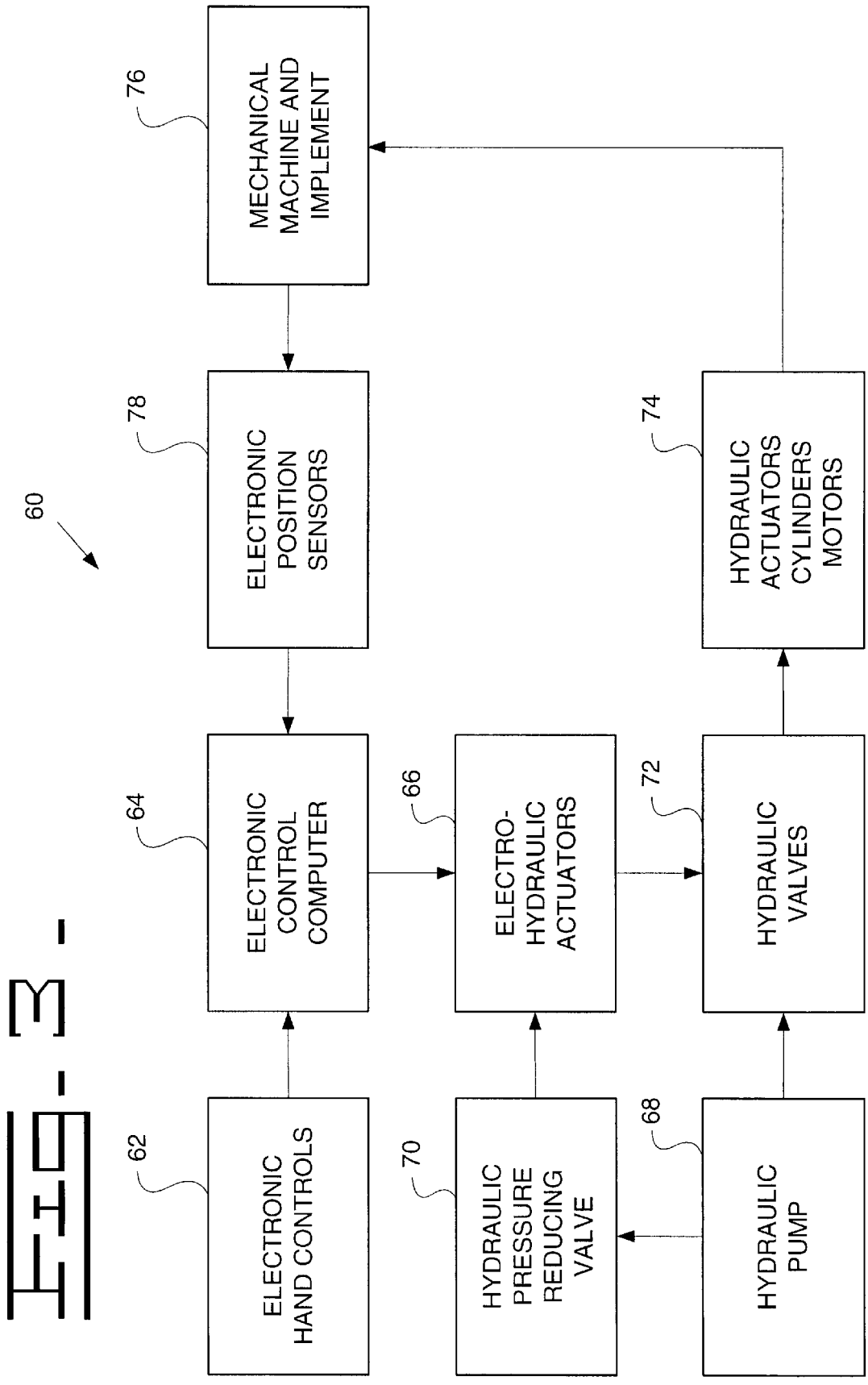
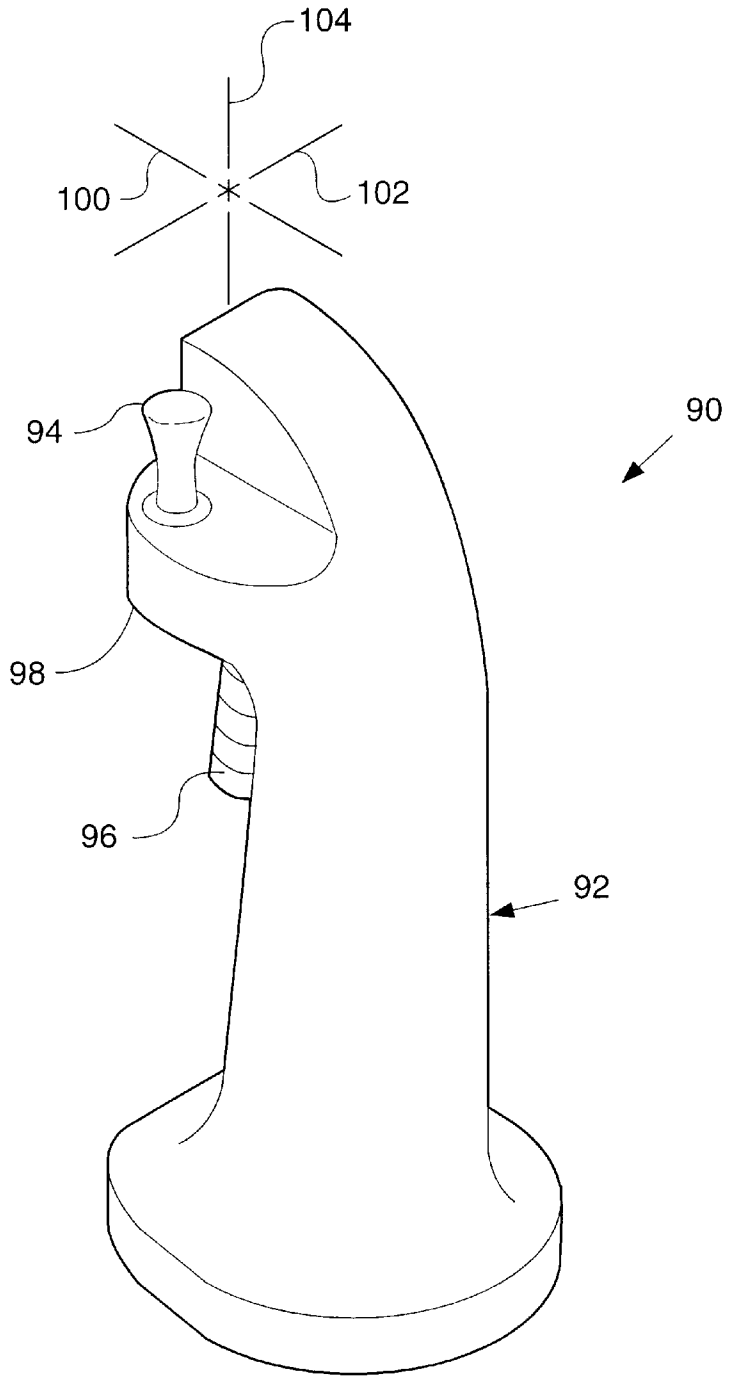

60
62
ELECTRONIC HAND CONTROLS
64
ELECTRONIC CONTROL COMPUTER
66
ELECTRO-HYDRAULIC ACTUATORS
68
HYDRAULIC PUMP
70
HYDRAULIC PRESSURE REDUCING VALVE
72
HYDRAULIC VALVES
74
HYDRAULIC ACTUATORS CYLINDERS MOTORS
76
MECHANICAL MACHINE AND IMPLEMENT
78
ELECTRONIC POSITION SENSORS

FIG. 3

Fig. 4



MINIATURE JOYSTICK MOUNTED ON A JOYSTICK

TECHNICAL FIELD

This invention relates generally to a motor grader and specifically to a miniature joystick mounted on a regular joystick for controlling a plurality of functions on a motor grader.

BACKGROUND ART

This invention relates generally to a miniature joystick mounted on a regular joystick for controlling a variety of functions of the motor grader.

Motor graders include many hand-operated controls to perform functions such as steering the grader, positioning an implement or a blade in several orientations, and articulating the frame of the grader.

Current motor graders require numerous hand-operated controls because typically each hand-operated control is used to control only one or two functions. Often, the operator of the motor grader must steer the grader while performing many other functions, such as adjusting the blade tip, adjusting the blade angle relative to the frame, and adjusting the articulation of the grader frame. Because the typical hand-operated controls are spaced apart, performing all of these functions simultaneously is difficult, inefficient, and fatiguing for the operator. To reduce difficulty, increase efficiency, and reduce operator fatigue, it is desirable to provide an apparatus that permits an operator to rapidly and easily control a plurality of functions from a single hand location. Also it is desirable to provide an apparatus that is ergonomically advantageous for controlling this plurality of functions.

DISCLOSURE OF THE INVENTION

The present invention provides a miniature joystick mounted on a regular joystick with both joysticks controlling a variety of functions of a motor grader.

In a first embodiment, a hand-operated control for a motor grader comprises a dual joystick having a first joystick and second joystick. The first joystick includes a control switch and a ledge. The second joystick is significantly smaller than the first joystick and is mounted on the ledge of the first joystick. In a preferred embodiment, the first joystick is movable on a first axis and a second axis wherein the first axis is perpendicular to the second axis. The first joystick is also rotatable about a third axis that is perpendicular to both the first axis and the second axis. In a preferred embodiment, movement of the first joystick on the first axis, second axis, or about the third axis generates a plurality of electrical input signals that are detected by an electrical control computer.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side view of a motor grader;

FIG. **2** is a top view of the motor grader;

FIG. **3** is a schematic block diagram of an electro-hydraulic control system for the motor grader; and

FIG. **4** is a side perspective view of a dual joystick designed in accordance with the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Referring to the Figures, wherein like numerals indicate like or corresponding parts throughout the several views, a

motor grader is shown generally at **10** in FIGS. **1** and **2**. The motor grader **10** is used primarily as a finishing tool to sculpt a surface of earth **11** to a final arrangement. Rather than moving large quantities of earth in the direction of travel like other machines, such as a bulldozer, the motor grader **10** moves relatively small quantities of earth from side to side.

The motor grader **10** includes a front frame **12**, a rear frame **14**, and a blade **16** having a top **15** and a cutting edge **17**. The front and rear frames **12** and **14** are supported by front tires **18** and rear tires **19**. An operator cab **20** containing the many controls necessary to operate the motor grader **10** is mounted on the front frame **12**. An engine, shown generally at **21**, is used to drive or power the motor grader **10**. The engine **21** is mounted on the rear frame **14**. The blade **16**, sometimes referred to as a moldboard, is used to move earth. The blade **16** is mounted on a linkage assembly shown generally at **22**. The linkage assembly **22** allows the blade **16** to be moved to a variety of different positions with respect to the motor grader **10**. Starting at the front of the motor grader **10** and working rearward toward the blade **16**, the linkage assembly **22** includes a drawbar **24**.

The drawbar **24** is mounted to the front frame **12** with a ball joint. The position of the drawbar **24** is controlled by three hydraulic cylinders, commonly referred to as a right lift cylinder **28**, a left lift cylinder **30**, and a center shift cylinder **32**. A coupling, shown generally at **34**, connects the three cylinders **28**, **30**, and **32** to the front frame **12**. The coupling **34** can be moved during blade repositioning but is fixed stationary during earthmoving operations. The height of the blade **16** with respect to the surface of earth **11** below the motor grader **10**, commonly referred to as the blade height, is controlled primarily with the right lift cylinder **28** and the left lift cylinder **30**. Each lift cylinder, **28** and **30**, functions to raise and lower the associated end of the blade **16**. Thus, the right lift cylinder **28** raises and lowers the right end of blade **16** and the left lift cylinder **30** raises and lowers the left end of blade **16**. The center shift cylinder **32** moves the drawbar **24** from side to side relative to the front frame **12**.

The drawbar **24** includes a large, flat plate commonly referred to as a yoke plate **36**, as shown in FIG. **2**. Beneath the yoke plate **36** is a large gear, commonly referred to as a circle **38**. The circle **38** is rotated by a hydraulic motor commonly referred to as a circle drive **40**, as shown in FIG. **1**. Rotation of the circle **38** by the circle drive **40** pivots the blade **16** about an axis A fixed to the drawbar **24**. The blade **16** is mounted to a hinge (not shown) on the circle **38** with a bracket (not shown). A hydraulic blade tip cylinder **46** is used to pitch the bracket forward or rearward and thus pitch the top **15** of the blade **16** forward and rearward relative to the cutting edge **17**. The blade **16** is mounted to a sliding joint in the bracket allowing the blade **16** to be slid or shifted from side to side with respect to the bracket. A hydraulic side shift cylinder **50**, shown in FIG. **2**, is used to control the side to side shift of the blade **16**.

Referring now to FIG. **2**, a right articulation cylinder, shown generally at **52**, is mounted to the right side of the rear frame **14** and a left articulation cylinder, shown generally at **54**, is mounted to the left side of the rear frame **14**. The right and left articulation cylinders **52** and **54** are hydraulic and used to rotate the front frame **12** about an axis B shown in FIG. **1**. The axis B is commonly referred to as the articulation axis. In FIG. **2**, the motor grader **10** is positioned in a neutral or zero articulation angle. The rear tires **19** are driven by a differential (not shown) as is well known in the art. The rear tires **19** on each side are geared to each other and are driven in synchrony by the differential. The motor grader **10**

includes a differential lock mechanism (not shown) as is known in the art. Preferably, the differential lock mechanism is turned off and on by a control switch **96** (see FIG. **4**). The differential lock locks the differential so that it drives both the right rear tires **19** and the left rear tires **19** even during a loss in traction and thus provides better traction as is known in the art.

FIG. **3** is a schematic block diagram of an electro-hydraulic control system **60** for the motor grader **10**. The control system **60** is designed to operate the various hydraulic controls of the motor grader **10** described above. The system **60** includes electronic hand controls represented by block **62**, which transform the actions of an operator's hands on controls such as dual joystick **90** (see FIG. **4**) into a plurality of electrical input signals. These input signals carry operational information to an electronic control computer, represented by block **64**.

The control computer **64** receives the electrical input signals produced by the hand controls **62**, processes the operational information carried by the input signals, and transmits a plurality of control signals to a plurality of drive solenoids, each of which is located in an electro-hydraulic actuator, represented by block **66**.

The hydraulic portion of the control system **60** requires both high hydraulic pressure and low pilot pressure. High hydraulic pressure is provided by a hydraulic pump, represented by block **68**. The hydraulic pump **68** receives a rotary motion, typically from the engine **21** of the motor grader **10**, and produces high hydraulic pressure. Low pilot pressure is provided by a hydraulic pressure reducing valve, represented by block **70**. The hydraulic pressure reducing valve **70** receives high hydraulic pressure from the hydraulic pump **68** and supplies low pilot pressure to the electro-hydraulic actuators **66**.

Each electro-hydraulic actuator **66** includes an electrical drive solenoid and a hydraulic valve. The solenoid receives control signals from the electronic control computer **64** and produces a controlled mechanical movement of a core stem of the actuator **66**. The hydraulic valve receives both the controlled mechanical movement of the core stem of the actuator **66** and low pilot pressure from the hydraulic pressure reducing valve **70** and produces controlled pilot hydraulic pressure for hydraulic valves, represented by block **72**.

The hydraulic valves **72** receive both controlled pilot hydraulic pressure from the electro-hydraulic actuators **66** and high hydraulic pressure from the hydraulic pump **68** and produce controlled high hydraulic pressure for hydraulic actuators, cylinders, and motors, represented by block **74**.

The hydraulic actuators, cylinders, and motors **74** receive controlled high hydraulic pressure from the hydraulic valves **72** and produce mechanical force to move the front frame **12** of the grader **10** and several mechanical linkages, represented by block **76**. As described above, movement of the front frame **12** of the grader **10** with respect to the rear frame **14** of the grader **10** establishes the articulation angle. Movement of the mechanical linkages establishes the position of the blade **16** or other implements.

Each hydraulic actuator, cylinder, and motor **74**, such as the lift cylinders **28** and **30** and the circle drive motor **40**, includes an electronic position sensor, represented by block **78**. The electronic position sensors **78** transmit information regarding the position of its respective hydraulic actuator, cylinder, or motor **76** to the electronic control computer **64**. In this manner, the control computer **64** can determine the articulation angle of the grader **10** and position the blade **16**. With such information, the control computer **64** can perform additional operations. 1. FIG. **4** is a side perspective view of a dual joystick shown generally at **90**. Dual joystick **90** comprises a first joystick **92** and a second joystick **94**. Second joystick **94** is significantly smaller than first joystick **92**. A control switch **96** is mounted to a front portion of first joystick **92**. Preferably, control switch **96** is an on off switch that is used to control the status of the differential lock described above. First joystick **92** includes a ledge **98** and second joystick **94** is mounted to ledge **98**. Ledge **98** serves to guide an operator's thumb to second joystick **94** without the need for the operator to look at first joystick **92**. First joystick **92** is movable on a first axis **100** and a second axis **102**. First axis **100** is perpendicular to second axis **102**. In addition, first joystick **92** is rotatable about a third axis **104** that is perpendicular to both first axis **100** and second axis **102**. Movement of first joystick **92** on any of the axes produces an electrical input signal that is received by the electronic control computer **64**.

Second joystick **94** is also movable along first axis **100** and second axis **102** and produces electrical input signals that are transmitted to the electronic control computer **64**. Preferably, second joystick **94** comprises an isometric joystick wherein the actual joystick moves a very short distance when moved through its full range of motion. With such a joystick the electrical input signal produced by the joystick is largely controlled by the force with which the joystick is moved in a given direction. A suitable example of second joystick **94** is Model 462 Subminiature Joystick available from Measurement Systems, Inc.

As would be understood by one of ordinary skill in the art, both first joystick **92** and second joystick **94** can also be moved along axes that are intermediate between first axis **100** and second axis **102**. Movement of either the first joystick **92** or the second joystick **94** along one of these intermediate axes produces a combination electrical input signal that reflects proportionally the angle of movement of the joystick between the first axis **100** and the second axis **102**.

As discussed above, movement of either first joystick **92** or second joystick **94** generates an electrical input signal that is received by electronic control computer **64**. These input signals can be utilized to control a variety of functions on motor grader **10** through the hydraulic actuators, hydraulic cylinders, and hydraulic motors represented by block **74** in FIG. **3**. By way of example only, movement of first joystick **92** on first axis **100** may be used to simultaneously activate right lift cylinder **28** and left lift cylinder **30** to accomplish a uniform lifting of blade **16**. Movement of first joystick **92** along second axis **102** can be utilized to generate control signals that actuate side shift cylinder **50** thereby shifting blade **16** from one side of frame **12** to the other side of frame **12**. Movement of first joystick **92** on an axis intermediate between first axis **100** and second axis **102** would simultaneously activate both right lift cylinder **28** and left lift cylinder **30** to accomplish a uniform lifting of blade **16** and actuate side shift cylinder **50** thereby shifting blade **16** from one side of frame **12** to the other side of frame **12**. Rotation of first joystick **92** about third axis **104** may be used to generate a control signal for activating circle drive **40** and thereby rotating blade **16** about axis A. Movement of second joystick **94** along first axis **100** may be used to activate hydraulic blade tip cylinder **46** and thereby move top **15** of blade **16** relative to cutting edge **17**. Likewise, movement of second joystick **94** along second axis **102** may be used to generate a control signal for actuating center shift cylinder **32** thereby moving drawbar **24** relative to frame **12**. As

would be understood by one of ordinary skill in the art, movement of either first joystick **92** or second joystick **94** along any one of first axis **100**, second axis **102**, and third axis **103** could be used to perform other functions of a motor grader **10**.

INDUSTRIAL APPLICABILITY

The present invention relates generally to a hand-operated control for performing a variety of functions on a motor grader **10**. In the present invention, a dual joystick **90** incorporates a first joystick **92** and a second joystick **94**. The second joystick **94** is significantly smaller than the first joystick **92**. First joystick **92** also includes a ledge **98**. Second joystick **94** is mounted to ledge. First joystick **92** further incorporates switch **96** for controlling a differential lock mechanism. Mounting of second joystick **94** on first joystick **92** permits dual joystick **90** to provide ergonomically advantageous control of a plurality of functions of motor grader **10** to an operator.

The present invention has been described in accordance with the relevant legal standards, thus the foregoing description is exemplary rather than limiting in nature. Variations and modifications to the disclosed embodiment may become apparent to those skilled in the art and do come within the scope of this invention. Accordingly, the scope of legal protection afforded this invention can only be determined by studying the following claims.

We claim:

1. A hand-operated control for a motor grader comprising:

a dual joystick having a first joystick and a second joystick;

said first joystick including a control switch and a ledge; and

said second joystick being significantly smaller than said first joystick and mounted on said ledge of said first joystick.

2. A hand-operated control for a motor grader as recited in claim **1** further comprising an electronic control computer and wherein said first joystick is movable on a first axis and a second axis;

said first axis perpendicular to said second axis;

said first joystick rotatable about a third axis, said third axis perpendicular to both said first axis and said second axis; and

movement of said first joystick on said first axis, said second axis, or about said third axis generating a plurality of electrical input signals, said plurality of electrical input signals detected by said electronic control computer.

3. A hand-operated control for a motor grader as recited in claim **2** further comprising a plurality of electro-hydraulic actuators each having a drive solenoid wherein said electronic control computer generates a control signal in response to each of said input signals, said electronic control computer transmitting said control signal to at least one of said electro-hydraulic actuators.

4. A hand-operated control for a motor grader as recited in claim **3** further comprising a hydraulic right lift cylinder and a hydraulic left lift cylinder, each of said hydraulic right lift cylinder and said hydraulic left lift cylinder associated with at least one of said plurality of electro-hydraulic actuators and wherein said electronic control computer transmits one of said control signals to each of said associated electro-hydraulic actuators of said hydraulic right lift cylinder and said hydraulic left lift cylinder in response to movement of said first joystick on said first axis.

5. A hand-operated control for a motor grader as recited in claim **3** further comprising a hydraulic side shift cylinder, said hydraulic side shift cylinder associated with at least one of said plurality of electro-hydraulic actuators and wherein said electronic control computer transmits one of said control signals to said associated electro-hydraulic actuator of said hydraulic side shift cylinder in response to movement of said first joystick on said second axis.

6. A hand-operated control for a motor grader as recited in claim **3** further comprising a hydraulic circle drive, said hydraulic circle drive associated with at least one of said plurality of electro-hydraulic actuators and wherein said electronic control computer transmits one of said control signals to said associated electro-hydraulic actuator of said hydraulic circle drive in response to rotation of said first joystick about said third axis.

7. A hand-operated control for a motor grader as recited in claim **1** further comprising an electronic control computer and wherein said second joystick is movable on a first axis and a second axis;

said first axis perpendicular to said second axis; and

movement of said second joystick on said first axis or said second axis generating a plurality of electrical input signals, said plurality of electrical input signals detected by said electronic control computer.

8. A hand-operated control for a motor grader as recited in claim **7** further comprising a plurality of electro-hydraulic actuators each having a drive solenoid wherein said electronic control computer generates a control signal in response to each of said input signals, said electronic control computer transmitting said control signal to at least one of said electro-hydraulic actuators.

9. A hand-operated control for a motor grader as recited in claim **8** further comprising a hydraulic blade tip cylinder, said hydraulic blade tip cylinder associated with at least one of said plurality of electro-hydraulic actuators and wherein said electronic control computer transmits one of said control signals to said associated electro-hydraulic actuator of said hydraulic blade tip cylinder in response to movement of said second joystick on said first axis.

10. A hand-operated control for a motor grader as recited in claim **8** further comprising a hydraulic center shift cylinder, said hydraulic center shift cylinder associated with at least one of said plurality of electro-hydraulic actuators and wherein said electronic control computer transmits one of said control signals to said associated electro-hydraulic actuator of said hydraulic center shift cylinder in response to movement of said second joystick on said second axis.

* * * * *