(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 950 351 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
30.07.2008 Bulletin 2008/31

(51) Int Cl.:
E01H 5/06 *(2006.01)*

(21) Application number: **08000867.5**

(22) Date of filing: **17.01.2008**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

(30) Priority: **17.01.2007 US 880901 P**

(71) Applicant: **Muncie Power Products, Inc.**
Muncie, Indiana 47308-0548 (US)

(72) Inventor: **Crago, Terry**
c/o Muncie Power Products, Inc.
Muncie, IN 47308-0548 (US)

(74) Representative: **Wagner, Karl H.**
WAGNER & GEYER
Patentanwälte
Gewürzmühlstrasse 5
80538 München (DE)

(54) **Electrohydraulic control system for a vehicle**

(57) An electronic control system and data-logging system for a snow removal vehicle. The vehicle includes hydraulically actuated tools, the control of which can be through a dual axis controller such as a joystick. Electrical communication among components in the system is provided by a power line carrier protocol (PLC).

EP 1 950 351 A2

Description

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of priority to U.S. Provisional Patent Application Serial No. 60/880,901, filed January 17, 2007, which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention pertains to electrohydraulic control systems for vehicles, including such systems that can be retrofitted onto an existing vehicle, and also including systems for control and removal of ice and snow.

SUMMARY OF THE INVENTION

[0003] One embodiment of the present invention pertains to improvements in the operation of snowplows, including the conversion of existing snowplows to include electronic control systems.

[0004] Yet another embodiment pertains to an apparatus for controlling a snowplow of a vehicle, comprising a hydraulically actuatable snowplow, a hydraulic actuator, an electronic controller, and dual input devices including a hand stick and a keypad.

[0005] Yet another embodiment pertains to an apparatus for controlling the snow removal functions of a vehicle, comprising a vehicle including a hydraulically actuatable snowplow and other actuatable tools, and a dual axis joystick with switches for establishing which tool is controlled by the joystick.

[0006] Yet another embodiment pertains to a method for controlling the snowplow of a truck, comprising a truck having an actuatable snow removal tool and a two axis controller, wherein the tool responds to the controller with a predetermined rate of movement.

[0007] Yet another embodiment pertains to a system for electronically logging the snow and ice removal functions for the vehicle, in which the vehicle includes a snowplow and a system for distributing a granular product on a roadway. The system further includes sensors pertaining to the snowplow and distribution system. The system further includes an electronic controller that receives the sensor signals, as well as other information about the state of the vehicle, this data being communicated to the controller over the vehicle power system. The controller compute data from this sensed data pertaining to the snow and ice removal functions of the vehicle, and makes that computed data available to a memory until or an AVL system.

[0008] In yet another embodiment of the present invention, there is an vehicle that has an electrohydraulic control system that permits the user to operate one or more snow and ice removal functions. The electronic controller of the system includes an algorithm that modifies the electrohydraulic control functions based on whether a particular tool uses a single acting or double acting hydraulic cylinder. In particular, another embodiment pertains to existing vehicles that have been retrofit with a kit, and this feature permits a single set of control algorithms to be used with different hydraulic actuators.

[0009] Yet another embodiment of the present invention pertains to a vehicle that includes a system for removing snow and ice from a roadway. Preferably, the computer receives a signal corresponding to road temperature. The algorithm can adjust the rate at which a granular product (such as salt) is applied to the roadway based on the roadway temperature. As one example, the rate at which the spreader applies the granular product to the roadway increases with decreasing temperature. In one embodiment, this relationship is linear.

[0010] It will be appreciated that the various apparatus and methods described in this summary section, as well as elsewhere in this application, can be expressed as a large number of different combinations and subcombinations. All such useful, novel, and inventive combinations and subcombinations are contemplated herein, it being recognized that the explicit expression of each of these myriad combinations is excessive and unnecessary.

DESCRIPTION OF THE DRAWINGS

[0011]

FIG. 1 is a top, right, and rear photographic representation of a vehicle 20 according to one embodiment of the present invention.

FIG. 2 is a left and rear photographic representation of a vehicle 20 according to another embodiment of the present invention.

FIG. 3 is a schematic representation of a vehicle control system according to another embodiment of the present invention.

FIG. 4 includes three mutually orthogonal views of an electrohydraulic interface unit 60 according to one embodiment of the present invention.

FIG. 5 is a frontal view of a keypad 80 according to one embodiment of the present invention.

FIG. 6 is a perspective photographic representation of a joystick 70 according to one embodiment of the present invention.

FIG. 7 is a table describing the valves, hydraulic actuators, and tool functions of a vehicle according to one embodiment of the present invention.

FIG. 8 is a wiring diagram according to one embodiment of the present invention.

FIG. 9 is a schematic representation of a portion of a vehicle control system according to one embodiment of the present invention.

FIG. 10 is a schematic representation of a portion of a vehicle control system according to one embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0012] For the purposes of promoting an understanding of the principles of the inventions, reference will now be made to the embodiments illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the inventions is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the inventions as illustrated therein being contemplated as would normally occur to one skilled in the art to which the inventions relate.

[0013] Various embodiments of the present invention pertain to improvements in the operation of electrohydraulic controls systems on a vehicle such as a truck. In particular, some embodiments pertain to trucks outfitted as snowplows, although other embodiments pertain to vehicles with various movable electrohydraulically actuated tools.

[0014] One aspect of the present invention pertains to a power distribution system intended to provide control over the electric portion of a medium or large hydraulic scheme. The system 40 will consist of a control panel and power distribution units. Depending upon the application, up to three power distribution units 50 provide control to various hydraulic components.

[0015] The control panel will communicate with one master power distribution unit using PLC (Power Line Carrier) technology. Examples of this technology include power systems in compliance with SAE Standard J1939, SAE Standard J1708, or RS-485. These standards are by example only, and are not intended to be limiting. Additional power distribution units will communicate with the master over a serial interface.

[0016] PLC technology can send control commands or sensory data through the vehicle voltage/ground connections anywhere upon the chassis. It can be used on applications that otherwise would require multi-conductor connections via traditional wiring harnesses. It can also have a positive impact on applications that require plurality in control locations. Multiple controls can be connected to the power/ground "bus" simultaneously or a single control can be plugged into "stations" throughout the vehicle. These could be cigarette lighter powerpoints. Applications involving trailers that would otherwise need multiconductor plug connections from truck to trailer greatly benefit. A datastream is superimposed on the electrical system at high frequency. Data is guarded against interference by constant frequency shifting and using digital protocols for collision resolution systems that establish priorities for data "crosstalk."

[0017] One embodiment of the present invention includes lighting controls and joystick cylinder control. A radio or modem transmitter sends real time location and application data to a dispatcher. A GPS receiver tracks the actual truck location. The use of pressure compensated hydraulics avoid the "Dead Stick." Electronically controlled downside pressure extends blade life. Electronic spreader controls automatically control application rate based on ground speed. Data loggers keep track of changes that the driver makes. A road and air temperature sensor interface is included. Some embodiments of the present invention utilize one or both of these temperature signals in a spreader control algorithm. Electronic encoders for material control are used. In yet other embodiments the output of the encoders is used only for recording purposes. In yet other embodiments material control is accomplished in accurate form with linear proportional hydraulic valve. A Pre-Wet Liquid applicator sprays granular product with advanced agents.

[0018] One aspect of the present invention pertains to electrohydraulic control systems 40 that can be retrofitted onto existing vehicles. The vehicles have one or more tools that use hydraulic power, such as a plow 22 or dump body 26. An operator inside the vehicle actuates the tools to a given position or to operate at a given speed. Further, it is understood that other types of hydraulically controlled tools are contemplated, including wing plows 24, gratings or grizzlies 28, tailgate augers 30, spinner 32, conveyor drives 34, spinner drives 36, and front and rear loading buckets. These tools are by example only, and are not intended to be limiting.

[0019] In some embodiments, the cab of the vehicle 20 includes both a joystick-type controller 70 and a keypad controller 80. Preferably, both the joystick 70 and the keypad 80 can be used to operate some of the same tools. As one example, movement of the joystick by the operator commands a tool to move at a rate or velocity that is proportional to the distance and direction that the joystick has moved. As another example, the keypad can control movement of the

same tool in the same directions, but at a rate that is fixed. The fixed, predetermined rate is implemented as an operator command upon movement of a switch from one position to another position.

[0020] In one embodiment, the joystick 70 includes a plurality of buttons 72, 73, and 74 by which various tools of the vehicle can be actuated. In one embodiment, buttons 72, 73, and 74 are provided for controlling the plow, scraper, and dump body, respectively. The vehicle operator selects between plow, dump or scraper operation by momentarily pressing the appropriate button on the joystick head. The selection will be locked in and displayed on the control panel with a lighted label (Plow, Dump, Scraper). However, the buttons of the joystick can be associated with control of any tool, and are not limited. Further, joystick 70 preferably includes a deadman button 71 which provides safe operation of the vehicle control system as described later herein.

[0021] In some embodiments, one of the data signals from either the joystick 70 or the keypad 80 is converted by an electrical interface unit 50 to a command signal. Preferably, this command signal is transmitted over a vehicle power bus to an electrohydraulic interface unit 60. Unit 60, in some embodiments, receives hydraulic fluid under pressure from a pump operated by a power take-off unit receiving power from the vehicle drivetrain.

[0022] The spreader or spinner 32 and its associated drive 36 are controlled with a variety of different programmed functions. The spreader on-off is controlled by simultaneously pushing auger and liquid knobs together. The spreader functions include:

(1) Auto-Man, Blast & Pause Operation:

[0023] The operator selects Auto or Manual operation by pressing the Liquid control and holding for two seconds and then releasing to see the change. Blast operation is initiated by pressing and releasing the Auger control knob. Blast will last a predetermined time and then normal spreader operation will resume. Pause operation of the spreader is initiated by pressing and releasing the Spinner control knob. Pressing and releasing the Spinner control knob again resumes spreader operations.

(2) Granular Product Selection Operation:

[0024] Up to 3 different granular material products can be selected for calibrated operation. These are designated Prod 1, 2 & 3 by the system. To change a Product selection, the operator holds the Spinner knob before the Spreader function is turned-on, and slightly turns the knob either direction. The display shown will appear. While holding the Spinner knob down, the operator turns it either direction to the desired Product number and then releases it.

(3) Auto Spreading Operation:

[0025] The operator pushes and holds the Liquid control for two seconds and releases it to switch from Man to Auto. The AUTO label flashes whenever the MPH is "0" or there is no speedometer connection. This also indicates the auger is not turning. The operator selects an Auger output by turning the Auger control to increase or decrease the display from "00" to "99". If the system has been weight calibrated, then the number displayed times 10 indicates the "LBS PER MILE" to be spread in Auto. (Ex. Display 47 X10 = 470 LBS/MILE). If the system has not been weight calibrated, then the operator adjusts the Auger control setting while observing the spread pattern in the mirrors. The Auto function will still adjust itself to produce the same pattern at all MPH.

(4) Manual Spreading Operation:

[0026] The operator pushes and holds the Liquid control for two seconds and releases it to switch from Auto to Man. The operator then adjusts the Auger control for "00, 10, 20, 30.....90, 99" on the display. These are reference values. The operator make an adjustment while observing the pattern in the mirrors. The setting results in a constant auger speed regardless of MPH. The operator uses the PAUSE function to stop and start at intersections, etc.

[0027] Preferably, the vehicle power bus 38 is a 12 volt DC bus, and the command signal is represented at one or more frequencies superimposed on the 12 volt DC bus, such as a powerline communication (PLC) signal transmitted in accordance with SAE #J1959. Interface module 50 is capable of receiving multiple command signals, multiplexing the signals onto the power bus, and demultiplexing these various command signals to produce individual actuation signals. It is understood that various embodiments of the present invention include one or more electronic control and/or data-logging modules. These electronic units are interchangeably referred to as modules, units, and controllers. It is understood that the functions of such devices can be included in a single physical unit or multiple physical units, on a single circuit board or on multiple circuit boards.

[0028] Electrohydraulic interface unit 60 receives the demultiplexed actuation signals and provides those signals to corresponding electrohydraulic converter mechanisms. As one example, hydraulic interfacing at 60 includes at least

one converter that includes a proportional cylinder that applies a force to a corresponding spool valve, the force being in proportion to the actuation signal. The spool valve responds to this force by providing hydraulic fluid to an actuation such as a piston and cylinder actuation that is coupled to the tool. The spool valve provides hydraulic fluid to the actuation at a commanded flow rate or at a commanded pressure.

[0029] Some embodiments of the present invention include a safety algorithm that monitors communication on the PLC power/databus. The primary electronic control unit receives command signals from the joystick and keypad, and transmits command signals via the power/databus to one or more distributed electronic controllers located remotely in the vehicle. A remote, distributed controller receives the command, and provides the appropriate command output, such as a current drive signal, to the electrohydraulic control valves. The distributed controller monitors communication traffic on the power/databus, and is programmed to receive messages four times per second. Between messages, the distributed controller (MPDU) latches its command output to the last command state. If a predetermined number of messages are missed by the distributed controller, then the distributed controller interrupts all outputs to provide safe operation. In one embodiment, the predetermined number of missed messages is four. In addition, if there is loss of PCL communication, the primary electronic controller will provide a visual indication at the control panel display for loss of PLC communication. As one example, the touch pads of the display do not change from green to red when buttons are pushed, and instead remain green.

[0030] FIG. 3, 9, and 10 refer to a schematic representation of a vehicle control system according to one embodiment of the present invention. Referring first to FIG. 9, some embodiments of the present invention further include a sensor system 90 which includes a plurality of sensors and switches 92, signals from which are received by a sensor input module 94. Module 94 is in communication via power bus 38 with a data capture module 96 that suitably converts the sensor data and provides it to an RS232 databus, to a memory device 98 to other portions of the control system 40. In one embodiment, sensor sweet 92 includes sensors and switches that provide signals corresponding to the following quantities: liquid flow turbine, hydraulic motor encoder, hydraulic pressure, gate elevation, oil temperature, oil level, filter bypass, no liquid, no material, dump up, scraper down, wing down, and plow down.

[0031] As best represented in FIGS. 3, 9, and 10, some embodiments of the present invention include a data logging system, which includes means for storing sensor data in a readily retrievable format, and also means for transmitting data to an automatic vehicle located (AVL) system. The data logging system preferably includes a base data-capture and memory storage system 98, and a databus, such as an RS-232 databus for streaming data serially to an AVL system. The data logging system further includes a sensor input module 94 and a sensor display 100 for the operator.

[0032] Data capture module 96 captures data representative of the state of the vehicle (velocity, odometer reading, position, etc.) and also the setting of the control system.. Preferably, the data captured in the data logging system includes: granular output rate setting (LBS/MILE in real time); granular product selection (PROD 1-3 in real time); truck speed (MPH in real time); liquid output rate setting (CONTROL PERCENTAGE in real time); spinner control setting (PERCENTAGE in real time); blast (ON in real time); pause (ON in real time); and totals per calendar day and per granular product selection (PROD 1-3), including, total granular weight per product; total granular miles; total granular minutes; total granular blast weight; total granular blast miles; total liquid minutes; and total liquid miles.

[0033] The data logging system further includes a real time clock embedded in the module. The day-date is appended to each of the "Total" files described above. The module's memory storage is a "thumb drive" other non-volatile, easily removable transportable memory device allowing easy transfer of data to a personal computer. Calibrations from the "as is" system are copied to the thumb drive. A truck identity is associated to the data files. The module will preferably be located in the truck cab. The data format is preferably stored as a comma delimited string. A serial communication capacity is used with AVL systems. Data transfer of the "Real Time" values described above can occur by a query protocol and/or by constant output stream of at least once per second.

[0034] In some embodiments, the data capture module is a module located in the hydraulic valve compartment that reads a variety of sensors and switches 92 that are in electrical communication with it, either via the PLC or via hardwire.. It makes the sensor information available for extended data-logging fields and for display to the operator. Some of the data available includes: hydraulic oil temperature, hydraulic oil level, filter bypass, road temperature, air temperature, hydraulic pressure, spreader material, gate elevation, plow down, wing down, and scraper down. Preferably, the data stored and made available for transmission by the data logging system complies with governmental specifications, including specifications by the Administrative Transportation of Ontario Province, Canada.

[0035] Preferably, the control module further reacts to out of range values for various levels of input data. As one example, if a sensor 92 indicates that the hydraulic oil level is low, then controller module 50 disengages (by relay) the appropriate hydraulic pumps or shifts the appropriate diverter valve.

[0036] In one embodiment, the present invention includes a display such as an LCD display mounted within site of the vehicle operator. Display 100 includes indicator lights with digital representations or analog representations from the sensor system 90. Various warning levels will be associated with many of the sensor signals and switch positions, and display 100 will preferably indicate any perimeters outside of these limits by various visual or audible flags. Further, in one embodiment, the display is a touch screen, and the vehicle electronic system includes an algorithm for programming

critical temperatures of road temperature and air temperature. Exceeding these ambient conditions also result in actuation of a visual or audible alarm.

[0037] Although details of various features of the control system are shown and described, it is understood that these are only by example, and are not limiting to the inventions. As one example, a control system according to another embodiment of present invention can be implemented on new vehicles as OEM equipment. In yet other embodiments the operator inputs can include, instead of a joystick, any type of switching device that can be moved in a direction over a range of positions, including slide switches and rotary switches. In yet other embodiments, keypad 80 can include, rather than manual switches, a touch screen or voice-activated functions. In yet other embodiments where the vehicle tools are pneumatically operated, there would also be a corresponding electropneumatic interface unit replacing the electrohydraulic interface unit. Further, other embodiments of the present invention contemplate the use of dedicated communication buses, rather than using commands implemented via PLC on a power bus.

[0038] The following pages will describe other elements, features, and aspects of different embodiments of the present invention. It is understood that all of the descriptions herein are by example only, and are not intended to be limiting.

[0039] In some embodiments of the present invention the system controls pertain to:

[0040] Cab-to-Valve Connection: Commands from the system controls to the system valves are preferably digitally encoded and sent over the vehicle electrical system using only a 12VDC and Ground connection at each end of the system.

[0041] Valve Driver Modules: The valve driver modules are preferably housed in Deutsch boxes and employ Deutsch connectors at the solenoids giving IP69 environmental rating.

[0042] The Driver Modules are preferably equipped with current sensing control to (1) offset thermal changes in solenoid performance, (2) to detect open or short circuit conditions and protect against the latter by automatic interruption of current to the shorted output.

[0043] Cylinder Controls (Pushbutton) via Keypad 80: Momentary pushbutton switches will provide on-off style control of the plow and dump body operations. Program settings will provide effective and independent flow trims for plow up-down, plow angle and dump up-down.

[0044] Cylinder Controls (Joystick 70): A two axis proportional joystick with deadman switch and pushbutton selection of equipment (i.e. Plow, dump hoist, etc.) are preferably provided. The joystick employs dual redundant hall-effect mechanisms, minimizing the wear of potentiometer or other contact mechanisms. In the event of failure of one hall-effect output a program adjustment to the system Controller will allow selection of the alternate channel. The same Controller will also provide electronic adjustment of: (1) degrees from center for operation (deadband), (2) minimum valve drive at minimum joystick deflection, (3) maximum valve drive at maximum joystick deflection. Adjustments 2 & 3 will be independent for each the plow and dump. The joystick plug to the control panel as its only connection point. Connection of the joystick will render the pushbutton cylinder controls inoperable. Conversely, disconnection of the joystick will reactivate the pushbutton controls. Selection of equipment function by pushbuttons on the head of the joystick will illuminate an equipment identity label on the control panel. No operation of the joystick can take place without holding the deadman switch.

[0045] To disable the pushbuttons, press the plow up and down simultaneously and hold for 5 seconds. The keypad lighting will switch from green to red. The buttons will remain red but will not operate. Repeat holding the plow up and down to reinstate the controls. To disable the joystick hold the plow and scraper selection buttons simultaneously for 5 seconds. The Plow, Dump and Scraper labels on the panel will go off. The joystick is now dead. Repeat the sequence to reinstate joystick control.

[0046] In some embodiments of the present invention the spreader controls pertain to:

a) Modes of Operation: Automatic and Manual control are preferably selectable.

b) Pause & Blast: There are preferably a Blast operation with programmable selection of level and time. A Pause operation are preferably available to momentarily disable the spreader operation.

c) Open-Loop Servo: A feedback sensor is not required to achieve accurate and consistent operation of the spreader functions.

d) Displays 86, 87, 88: High brightness LED numerical displays will be used to indicate one of 11 reference control positions for the spinner and auger (manual mode). In Auto operation the auger display will indicate "pounds per mile" if the system has been calibrated for such.

Fault Displays: The system displays occurrences of shorted or open outputs at the valves with indication of which circuit is responsible.

Liquid Operation: The system includes control for the operation of a pre-wetting liquid function. The control of this function are preferably operable as a groundspeed proportional output or as a strictly manual control. A LED numerical display will indicate the output of this system by reference numbers. The Liquid Pre-wet On-Off is controlled by simultaneously pushing the Liquid and Spinner knobs together.

[0047] Some embodiments of the present invention include a software algorithm in the vehicle's computer controller that adjusts the spreader control based on road temperature when the spreader control is in the AUTO mode. The algorithm would vary the auger rate as a percentage of its operation in accordance with the variance of road temperature about a target value. The percentage of change can be set by the user, as well as the target value of road temperature, and the upper and lower limits on road temperature. In one embodiment, the change in auger operation is linearly related to variation and road temperature. Preferably, the slope of this relationship is in the range of about 0.5 percent/degree to about 2 percent/degree. As one example, the desired auger output (expressed as 100 percent) would be established at a target temperature such as 27.5 degrees F. For each degree that road temperature is below 27.5 degrees, the output of the auger is changed (preferably raised) about 1 percent.

[0048] In some embodiments of the present invention the control definitions pertain to:

Cylinder operations: Momentary pushbutton control.

Auger/Spinner operations: Rotary control input with marked positions or momentary increase/decrease pushbutton and with a numerical or bargraph indicator of output magnitude.

Blast operation: A momentary pushbutton that increases the auger drive to maximum while depressed and maintains that operation after release for an adjustable time delay of 0-30 seconds..

Pass or Pause operation: A momentary pushbutton that interrupts the spreader operation while depressed.

Spreader On/Off: Alternate push on/push off control of the spreader operation. The Spreader On/Off is controlled by simultaneously pushing the Auger and Liquid knobs together.

Auto/Manual Spreader operation: Alternate pushbutton selection of Auto (groundspeed proportional) operation of the spreader or Manual (no groundspeed proportioning). Automatic operation should automatically drop the auger and spinner drives at 0 MPH.

Pre-Wet operation: Pushbutton On/Off control. Momentary pushbuttons or rotary controls for increasing and decreasing the motor/pump speed. Similar to the spreader controls. If pushbuttons are used then a numerical or bargraph display of the drive magnitude is required. The pre-Wetting drive is proportional to the vehicle speed. The pre-wetting systems includes one or more tanks, spray bars, and pumps for pre-wetting the granular material.

Controls Summary: the control system preferably includes capability to perform the following functions: Spreader On/off, Auger increase/decrease, Spinner increase/decrease, Blast, Pass or Pause, Plow raise, Plow lower, Plow left; Plow right, Dump raise, Dump lower, Pre-Wet On/off, and Pre-Wet increase/decrease. The Plow and Dump Keypad On-Off is controlled from the ignition on-off.

Adjustability/Programmability: Operating parameters such as the spreader minimum/maximum trims described before and others described below can be adjusted in the user calibration program. The operating parameters include: Spreader valve minimum/maximum trims, Pre-Wet motor minimum/maximum trims, Blast time-out delay, Speedometer input calibration, and Single/Double acting cylinder operations (as indicated in Fig. 7).

[0049] Control system 40 includes a plurality of different adjustment capabilities. To enter the adjustment mode, with the spreader control off - the operator presses the Auger and Spinner knobs together and holds for two seconds. After the controller powers up in the Adjustment Mode (CA), the operator enters a Pass Code using the Liquid and Spinner displays and knobs (pressing the Spinner knob to enter the value). If the wrong value is entered, the screen will go blank.

[0050] The user scrolls through the menu of keypad 80 in the following manner. After entering the proper passcode the first line of the menu of adjustments will appear as shown. The user may scroll through the menu items by turning the Auger control knob. The menu items preferably include the following:

Auger (Min) Lo and Auger (Max Hi): Auger LO sets the lowest speed available to the operator. It should be high enough to cause the Auger or Conveyor to turn. The operator turns the Spinner knob to adjust the value and then presses to enter. Auger HI sets the highest speed available to the operator. The operator turns the Spinner knob to adjust the value and then presses to enter.

Spinner (Min) Lo and Spinner (Max Hi): Spinner LO sets the lowest speed available to the operator. It should be set high enough to cause Spinner movement. The operator turns the Spinner knob to adjust the value and then presses to enter. Spinner HI sets the highest speed available to the operator. The operator turns the Spinner knob to adjust the value and then presses to enter.

Liquid (Min) Lo and Liquid (Max) Hi: Liquid LO sets the lowest output flow available to the operator. It should be set high enough to cause some flow. The operator urns the Spinner knob to adjust the value and then presses to enter Liquid HI sets the highest output flow available to the operator. The operator turns the Spinner knob to adjust the value and then presses to enter

Blast Timer and Level Settings: Blast (to) sets the Time-Out function on Blast operations. This can be set for 0-30 seconds of operation after the Blast button is released. The operator uses the Spinner knob to select and pushes to enter the value. Blast HI sets the Auger or Conveyor speed for the Blast operation. This can be 0-99% of full

capacity. The operator uses the Spinner knob to select and pushes to enter the value.

Speedometer Input Type: GS or Groundspeed is asking for the type of speedometer input. The user is presented with options for choosing the type of transmission provided in their vehicle, such as for Allison or International Transmissions.

Speedometer MPH Matching : GS CA is the Groundspeed Calibration. It is used to synchronize the control system to the truck. The operator adjusts the Spinner display to a target MPH, drives the truck until the target speed is reached, and holds steady. The operator then pushes the Spinner knob while the truck is at the target speed and checks the results by slowing and reaccelerating. The Spinner display will blink and an audible tone will be heard when the speed matches again.

Weighted Dump Calibration: The operator fills the truck with material, weighs it, and positions the truck to discharge material. The hydraulic pump should be operating and the engine speed should be at least 1500 RPM. The operator sets the Auger (rt) rate on the Spinner display to a mid-level value (30-70) and presses the Spinner knob to start the dump process. The operator then pushes the Spinner knob again to stop the dump process, reweighs the truck and subtracts from the first weight to determine the dumped pounds of material. The operator enters the dumped pounds using the Liquid and Spinner knobs and displays and pushes the Spinner knob to enter the value.

Plow and Dump Cylinder Type: If the Plow lift cylinder is single-acting set the Spinner display for 1. If it is a double-acting cylinder set it for 0. Press the Spinner knob to enter the value. If the Dump hoist cylinder is single-acting set the Spinner display for 1. If it is a double-acting cylinder set it for 0. Press the Spinner knob to enter the value. The valves of the electrohydraulic control unit are configured in advance for single or double acting cylinder operations. This program selection allow for the microcontroller to apply hydraulic power for retraction of double acting cylinders, or not apply hydraulic power for retraction of single acting cylinders (i.e., gravity down).

Plow (Min) Lo and Plow (Max Up and Down) dr: For Joystick users, the Plow LO and (dr) will set the low and high Plow (up & down) flows for the travel of the Joystick. The operator sets each on the Spinner display and pushes the Spinner knob to enter the values. For Keypad users, the Plow LO serves no function and can be ignored. The Plow (dr) "drive" will allow trimming the flow or speed of the Plow (up & down) operation' when those keypads are pressed. The operator sets a value on the Spinner display and pushes the Spinner knob to enter.

Plow Angle (Max left & right) dr: This setting allows for trimming the speed of the angle operation when the joystick is full left or right. It also determines the speed of the angle operation when the left and right arrowed pushbuttons are used on the keypad control. The operator adjusts the value in the Spinner window with the Spinner knob and pushes the Spinner knob to install the setting into the system.

Dump (Min Lo and Dump (Max) dr: For Joystick users, the Dump LO and (dr) will set the low and high Dump flows for the travel of the Joystick. The operator sets each on the Spinner display and pushes the Spinner knob to enter the values. For Keypad users, the Dump LO serves no function and can be ignored. The Dump (dr) "drive" will allow trimming the flow or speed of the Dump operation when those keypads are pressed. The operator sets a value on the Spinner display and pushes the Spinner knob to enter.

Joystick Deadband: This adjustment will determine the sensitivity of the Joystick as it is moved off center. The operator sets the Spinner display for 0-5 to determine how far from center the Joystick should be moved before operation begins.

Backup Joystick Channels (Up and Down) The joystick has the feature of having two sets of output mechanisms. If the primary channel fails the operator has the recourse of switching to the backup channel to "repair" the joystick. If the operator loses operation on the raise-lower function "Fb" (forward-back) he can select "channel 1" to restore function. "Channel 0" is the factory default or primary. The operator uses the Spinner knob, displays to change channels, and pushes the spinner knob after the selection to lock it in.

Backup Joystick Channels (Left an Right): A backup channel is also assigned to the left-right function of the joystick. (See preceding instruction) The operator selects "channel 1" if experiencing a problem with the left-right joystick operation. "Channel 0" is the factory default and primary channel. The operator uses the Spinner knob, displays to change to "channel 1," and locks in the setting by depressing the Spinner knob.

Product 2 and 3 Weight Ratios: The product used to perform the Weighed-dump calibration is Product 1 and is the reference product. The weight ratio of Product 2 and Product 3 as compared to Product 1 can be entered as a percentage 50-150% on the Spinner display and entered by pushing the Spinner knob. Example: If the weight of Product 2 is half of Product 1 enter 50. If Product 3 is 20% heavier than Product 1, enter 120.

[0051] Auto Mode Take Off Timer The AUTO mode has a (to) take-off timer that will cause the Auger speed to operate at the Blast level for however many seconds have been set on this feature whenever the truck starts from 0 MPH. The operator sets the Spinner display for 0-9 seconds and pushes the Spinner knob to enter the value.

[0052] In some embodiments of the present invention the functional description pertains to:

Control Panel 80 The panel will control outputs at power distribution units, display measurements and settings,

provide diagnostic feedback, and allow access to the calibration menu. The following items describe the inputs, outputs, and functionality of the control panel.

AUGER label backlight 86 - yellow ; Illuminates yellow when power is supplied to the control panel, remains on when the spreader is turned on. Illuminates yellow and flashes if the auger output is open, or the rated current for the auger output has been exceeded.

LIQUID label backlight 87 - yellow: Illuminates yellow when power is supplied to the control panel, remains on when the spreader is turned on. Illuminates yellow and flashes if the liquid output is open, or the rated current for the liquid output has been exceeded.

SPINNER label backlight 88 - yellow : Illuminates yellow when power is supplied to the control panel, remains on when the spreader is turned on. Illuminates yellow and flashes if the spinner output is open, or the rated current for the spinner output has been exceeded.

Auger Rate Display 86 - Red seven segment: Spreader Auto Mode - Displays the auger dispense rate in 10*lbs/mile. The displayed value will range from 00 to 80 with a resolution of 05. Spreader Manual Mode - Displays reference value that corresponds to the auger dispense rate. A reference value of 10 will correspond to the auger minimum trim value, while a value of 99 will correspond to the auger maximum trim value. The displayed value will range from 00 (off) to 99(maximum trim) in increments of 10.

Liquid Rate Display 87 - Red seven segment: Displays reference value that corresponds to the liquid dispense rate. A reference value of 10 will correspond to 10/100*auger reference value * trimmed liquid range, while a value of 99 will correspond to 99/100*auger reference value * trimmed liquid range. The displayed value will range from 00 (off) to 99(maximum trim) in increments of 10.

Spinner Rate Display 88 - Red seven segment: Displays reference value that corresponds to the spinner dispense rate. A reference value of 10 will correspond to the spinner minimum trim value, while a value of 99 will correspond to the spinner maximum trim value. The displayed value will range from 00 (off) to 99(maximum trim) in increments of 10.

Auger Rate Knob 81 - Rotary encoder with spst pushbutton: Simultaneously pressing the auger rate knob along with the liquid rate knob will enable the auger and spinner outputs (spreader). Upon enabling the auger and spinner, the auger rate display and spinner rate display will turn on at a value of 00 (off). Upon being enabled, the auger and spinner outputs will correspond to the display readings and will be off.

[0053] Pressing the auger rate knob will set the auger output to the "blast level" as defined in the calibration settings. The auger rate display will display "bL" during a blast event. The blast level will be maintained for as long as the button is depressed, and will continue after the button is released for the "blast time out" period as defined in the calibration menu. During a blast event, if the auger rate knob is pressed before the "blast time out" period has expired, the blast event will be interrupted, and the auger will return to the pre-blast value.

[0054] Spreader Auto Mode - Turning the auger rate knob clockwise will increase the dispensed material rate in 50lbs/mile increments. The auger output will supply the current to dispense the displayed rate output. When the maximum value of 800 lbs/mile is reached, the rate value will remain at 800 regardless of further clockwise turns. Turning the auger rate knob counterclockwise will decrease the dispensed material in 50lbs/mile increments. When the minimum value of 00 lbs/mile is reached, the value will remain at 00 regardless of further counterclockwise turns.

[0055] Spreader Manual Mode - Turning the auger rate knob clockwise will increase the displayed reference value in increments of 10. The auger output will provide output current corresponding to the reference value. When the maximum value of 99 is reached, the value will remain at 99 regardless of further clockwise turns. Turning the auger rate knob counterclockwise will decrease the reference value in increments of 10. When the minimum value of 00 is reached, the value will remain at 00 regardless of further counterclockwise turns.

[0056] With the spreader enabled, simultaneously pressing the auger rate knob along with the liquid rate knob will disable the auger and spinner outputs (spreader). If enabled, the liquid output will also be disabled. The auger, liquid and rate displays, will turn dark.

[0057] Liquid Rate Knob 82 - Rotary encoder with spst pushbutton: Simultaneously pressing the liquid rate knob along with the spinner rate knob will enable the liquid output. The liquid rate display will turn on with a value of 00 (off). Upon being enabled, the liquid output will correspond to the display reading and will be off. If the spreader is off, pressing the liquid and spinner rate knobs will not enable the liquid output, and the liquid display will remain dark.

[0058] Pressing and releasing the liquid rate knob will toggle the mode of the spreader between the "AUTO" and "MANUAL" settings. The switch should be depressed and held for >1sec to change settings.

[0059] Turning the liquid rate knob clockwise will increase the displayed liquid reference value in increments of 10. When the maximum value of 99 is reached, the value will remain at 99 regardless of further clockwise turns. Turning the auger rate knob counterclockwise will decrease the reference value in increments of 10. When the minimum value of 00 is reached, the value will remain at 00 regardless of further counterclockwise turns. The liquid output provides output current that is a percentage of the trimmed liquid output range equal to the liquid reference value/100 * reference auger value.

[0060] With the liquid output enabled, simultaneously pressing the liquid rate knob along with the spinner rate knob will disable the liquid output. When disabled, the liquid rate display will turn dark.

[0061] Spinner Rate Knob 83 - Rotary encoder with spst pushbutton: Turning the spinner rate knob clockwise will increase the reference value in increments of 10. The spinner output will provide output current corresponding to the reference value. When the maximum value of 99 is reached, the value will remain at 99 regardless of further clockwise turns. Turning the auger rate knob counterclockwise will decrease the reference value in increments of 10. When the minimum value of 00 is reached, the value will remain at 00 regardless of further counterclockwise turns.

[0062] Pressing and releasing the spinner rate knob will pause the spreader, causing the auger, liquid, and spinner outputs to turn off. The auger rate, liquid rate, and spinner rate displays will display PA US E. Once paused, pressing the liquid rate knob again will un-pause the spreader, returning the auger, spinner, and liquid outputs to their pre-pause values.

[0063] With the spreader off, pressing, holding and turning the spinner rate knob, will allow the user to select the dispense product as 1, 2, or 3. The button should first be pressed for > 1 second. PR 0d will be displayed in the auger rate and liquid display's along with the current product 01, 02, or 03 in the spinner rate display. Turning the spinner rate knob will cycle through the 3 values. Upon selecting the desired value, and releasing the button, the new product will be used, and the display will return to previous settings. Product ratio 1 will be 1:1 with the calibrated dispense rate, product ratio 2 and 3 will be the ratio entered in the respective calibration menu items.

[0064] AUTO label backlight - yellow: Illuminates yellow when the spreader is in automatic mode with groundspeed signal. Automatic mode is the default spreader mode upon power up. Flashes yellow when the spreader is in automatic mode with no groundspeed signal.

[0065] MAN label backlight - yellow: Illuminates yellow when the spreader is in manual mode.

[0066] PLOW label backlight - yellow: Illuminates yellow when the joystick is in the plow mode. Plow mode is the default joystick mode upon power up. Illuminates yellow and flashes if a plow output is open, or the rated current for a plow output has been exceeded.

[0067] DUMP label backlight - yellow: Illuminates yellow when the joystick is in the dump mode. Illuminates yellow and flashes if a dump output is open, or the rated current for a dump output has been exceeded.

[0068] SCRAPER label backlight - yellow: Illuminates yellow when the joystick is in the scraper mode. Illuminates yellow and flashes if a scraper output is open, or the rated current for a scraper output has been exceeded.

[0069] Plow down pushbutton 84.1 - momentary spst switch : If a joystick is present at power on, the backlight remains dark and the pushbutton is ignored until the joystick is removed and power is cycled.

[0070] If the button is pressed at power on, the backlight will remain dark and the button press will be ignored until released and pressed again. If no joystick is present at power on, the backlight illuminates green, and the button is monitored. If pressed, the plow down backlight changes from green to red, and a single audible beep is generated. The plow flow control output is set to the flow control valve drive value as defined in the calibration menu. The unloader output is turned on, and the plow down output is turned on. When the button is released the three outputs will turn off and the backlight will return to green. If an open output or over current is detected at the plow down output while the button is pressed, the plow down output will turn off and the button backlight will flash red and dark with audible beeps.

[0071] Plow left pushbutton 84.2 - momentary spst switch: If a joystick is present at power on, the backlight remains dark and the pushbutton is ignored until the joystick is removed and power is cycled. If the button is pressed at power on, the backlight will remain dark and the button press will be ignored until released and pressed again. If no joystick is present at power on, the backlight illuminates green, and the button is monitored. If pressed, the plow left backlight changes from green to red, and a single audible beep is generated. The plow flow control output is set to the flow control valve drive value as defined in the calibration menu. The unloader output is turned on, and the plow left output is turned on. When the button is released the three outputs will turn off and the backlight will return to green. If an open output or over current is detected at the plow left output while the button is pressed, the plow left output will turn off and the button backlight will flash red and dark with audible beeps.

[0072] Plow right pushbutton 84.3 - momentary spst switch: If a joystick is present at power on, the backlight remains dark and the pushbutton is ignored until the joystick is removed and power is cycled. If the button is pressed at power on, the backlight will remain dark and the button press will be ignored until released and pressed again. If no joystick is present at power on, the backlight illuminates green, and the button is monitored. If pressed, the plow right backlight

changes from green to red, and a single audible beep is generated. The plow flow control output is set to the flow control valve drive value as defined in the calibration menu. The unloader output is turned on, and the plow right output is turned on. When the button is released the three outputs will turn off and the backlight will return to green. If an open output or over current is detected at the plow right output while the button is pressed, the plow right output will turn off and the button backlight will flash red and dark with audible beeps.

[0073] Plow up pushbutton 84.4 - momentary spst switch: If a joystick is present at power on, the backlight remains dark and the pushbutton is ignored until the joystick is removed and power is cycled. If the button is pressed at power on, the backlight will remain dark and the button press will be ignored until released and pressed again. If no joystick is present at power on, the backlight illuminates green, and the button is monitored. If pressed, the plow up backlight changes from green to red, and a single audible beep is generated. The plow flow control output is set to the flow control valve drive value as defined in the calibration menu. The unloader output is turned on, and the plow up output is turned on. When the button is released the three outputs will turn off and the backlight will return to green. If an open output or over current is detected at the plow up output while the button is pressed, the plow up output will turn off and the button backlight will flash red and dark with audible beeps.

[0074] Dump down pushbutton 85.1 - momentary spst switch: If a joystick is present at power on, the backlight remains dark and the pushbutton is ignored until the joystick is removed and power is cycled. If the button is pressed at power on, the backlight will remain dark and the button press will be ignored until released and pressed again. If no joystick is present at power on, the backlight illuminates green, and the button is monitored.

[0075] If pressed, the dump down backlight changes from green to red, and a continuous audible beep is generated. The unloader output is turned on, and the hoist down output is set to the dump hoist valve drive value as defined in the calibration menu. When the button is released the two outputs will turn off and the backlight will return to green. If an open output or over current is detected at the hoist down output while the button is pressed, the hoist down output will turn off and the button backlight will flash red and dark with audible beeps.

[0076] Dump up pushbutton 85.2 - momentary spst switch: If a joystick is present at power on, the backlight remains dark and the pushbutton is ignored until the joystick is removed and power is cycled. If the button is pressed at power on, the backlight will remain dark and the button press will be ignored until released and pressed again. If no joystick is present at power on, the backlight illuminates green, and the button is monitored.

[0077] If pressed, the dump up backlight changes from green to red, and a continuous audible beep is generated. The unloader output is turned on, and the hoist up output is set to the dump hoist valve drive value as defined in the calibration menu. When the button is released the two outputs will turn off and the backlight will return to green. If an open output or over current is detected at the hoist up output while the button is pressed, the hoist up output will turn off and the button backlight will flash red and dark with audible beeps.

[0078] Joystick 70 with pushbutton inputs 71, 72, 73, 74 - A locking connector at the back of the control panel housing will allow for connection of a sensor such as a Penny Giles joystick part# JC6000-XY-HMM-M-S-NL-N-STN-A30D. The joystick will allow control over three hydraulic functions, the plow, hoist, or scraper.

[0079] At the joystick input if more than one deflection axis is selected, the largest value will take priority, and the smaller value will be ignored. The joystick will not respond to angle deflection in any direction that is less than the joystick neutral dead band range as defined in the calibration menu. During operation of the joystick, if the user releases the dead man's trigger, any associated output will be turned off. The joystick should then be returned to the center position before the output can be re-enabled by pulling the dead man trigger, and deflecting the joystick. The joystick will be ignored unless connected to the control panel before power is applied.

[0080] The joystick will default to PLOW control upon power up, causing the PLOW label at the control panel to illuminate. The trigger (dead man) switch is pulled and held while the joystick is in the center position, or any joystick movement will be ignored. If the trigger switch is released after the start of a joystick movement, any output will be turned off.

[0081] Pressing 1 of the three pushbutton switches on the top of the joystick will change the function control of the joystick. The joystick is in the center position or the button press will be ignored. Pressing and releasing the top right button will produce a single audible beep and change the function control mode of the joystick to the scraper. The scraper label on the control panel will illuminate.

[0082] Scraper control mode - Moving the joystick away from the user will turn on the scraper down output, and set the flow control output current to a value corresponding to the angle deflection of the joystick. Moving the joystick towards the user will turn on the scraper up output, and set the flow control output current to a value corresponding to the angle deflection of the joystick. Moving the joystick to the left will turn on the scraper left output, and set the flow control output current to a value corresponding to the angle deflection of the joystick. Moving the joystick to the right will turn on the scraper right output, and set the flow control output current to a value corresponding to the angle deflection of the joystick.

[0083] Pressing and releasing the bottom middle button will produce a continuous audible beep and change the function control mode of the joystick to dump. The audible beep will continue for as long as the joystick is in the dump control mode. The dump label on the control panel will illuminate. Once in the dump mode, if the joystick remains in the neutral position for greater than 30 seconds, the mode will automatically change to plow.

[0084] Dump control mode - Moving the joystick away from the user will set the hoist down output current to a value corresponding to the angle deflection of the joystick. Moving the joystick towards the user will set the hoist up output current to a value corresponding to the angle deflection of the joystick.

[0085] Pressing and releasing the top left button will produce a single audible beep and change the function control mode of the joystick to plow. The plow label on the control panel will illuminate.

[0086] Plow control Mode - Moving the joystick away from the user will turn on the plow down output, and set the flow control output current to a value corresponding to the angle deflection of the joystick. Moving the joystick towards the user will turn on the plow up output, and set the flow control output current to a value corresponding to the angle deflection of the joystick. Moving the joystick to the left will turn on the plow left output, and set the flow control output current to a value corresponding to the angle deflection of the joystick. Moving the joystick to the right will turn on the plow right output, and set the flow control output current to a value corresponding to the angle deflection of the joystick.

[0087] Calibration Menu -Accessing the calibration menu will the completion of a startup sequence and entry of a 4-digit user pass code. After power is applied to the system, but before the spreader is enabled, simultaneously pressing the blast (auger rate knob), liquid rate knob, and pause (spinner rate knob) buttons allows entry of the pass code. The buttons is held for > 2sec. After the sequence is performed, the auger display will read CA, and the liquid and spinner displays will read from left to right a 4-digit value of 0000. Rotating the liquid rate knob clockwise will increase the 2 most significant digits value in 1-step increments. Rotating the liquid rate knob counterclockwise will decrease the value in 1-step increments. Rotating the spinner rate knob clockwise will increase the 2 least significant digits value in 1-step increments. Rotating the spinner rate knob counterclockwise will decrease the value in 1-step increments. Upon reaching the desired pass code, the user will press and release the spinner rate knob. If the pass code is incorrect, the auger, liquid, and spinner displays will go dark and the user should repeat the startup sequence. A factory master pass code of 5555 will allow entry into the calibration menu.

[0088] Once in the calibration menu of Table 1, items listed below may be accessed for calibration. Scrolling through the menu items is accomplished by turning the auger rate knob. Unless otherwise noted, turning the spinner rate knob allows selection of the value, and pressing the spinner rate knob updates the value in memory.

Table 1

MENU ITEM	AUGER DISPLAY	LIQUID DISPLAY	SPINNER DISPLAY
Auger Min Trim	AU	LO	VALUE (0-99)
Auger Max Trim	AU	HI	VALUE (0-99)
Spinner Min Trim	SP	LO	VALUE (0-99)
Spinner Max Trim	SP	HI	VALUE (0-99)
Liquid Min Trim	LI	LO	VALUE (0-99)
Liquid Max Trim	LI	HI	VALUE (0-99)
Groundspeed input Selection	GS		VALUE (0-2)
Blast Time Out Seconds	BL	TO	VALUE (0-30)
Blast Level	BL	HI	VALUE (0-99)
Speedometer calibration/verification	GS	CA	VALUE (10-40)
Auger rate calibration	AU	RT	VALUE (0-10)
Liquid PWM Frequency Hz - (50-200)	LF		VALUE (50-200)
Flow Control Valve Drive	FC	DR	VALUE (0-99)
Dump Hoist Valve Drive	DH	DR	VALUE (0-99)
Flow Control Min Trim	PF	LO	VALUE (0-99)
Flow Control Max Trim	PF	HI	VALUE (0-99)
Hoist up Min Trim	HU	LO	VALUE (0-99)
Hoist up Max Trim	HU	HI	VALUE (0-99)
Hoist down Min Trim	HD	LO	VALUE (0-99)
Hoist down Max Trim	HD	HI	VALUE (0-99)

(continued)

MENU ITEM	AUGER DISPLAY	LIQUID DISPLAY	SPINNER DISPLAY
Joystick neutral Dead band	JY	DB	VALUE (0-5)
Product 2 material ratio	PR	02	VALUE (0.5-1.5)
Product 3 material ratio	PR	03	VALUE (0.5-1.5)
Pass code change	PC		VALUE (0-9999)
Auto Mode Takeoff	AM	TO	VALUE (0-9)
Exit menu	EX	IT	

[0089] With regards to speedometer calibration, Upon entering this menu item, the user will turn the spinner rate knob to set the desired MPH value for calibration or verification. If the user desires to re-calibrate, they should accelerate the vehicle to the selected MPH value. While maintaining the selected vehicle speed pressing the spinner rate knob will complete calibration. If the present speed of the vehicle reaches the displayed MPH value(based upon the present calibration value), the MPH value will flash.

[0090] With regards to auger rate calibration, this calibration includes 3 operations, start cal, stop cal, and enter dispensed material weight. Start Cal - Upon entering this menu item, the user will turn the spinner rate knob to set the reference value for the auger speed, and press the spinner rate button. The auger output will provide output current corresponding to the reference value. Stop Cal - The user will press the spinner rate button again to stop the auger output. The display will show "LB VALUE (0000-5000)." Enter weight - Next the auger rate display will read LB, with the liquid and spinner displays reading 00 and 00. The user will turn the liquid rate knob clockwise to increase and counter clockwise to decrease (1 step increments), until the liquid display digits match the 2 most significant digits of the dispensed material weight in pounds. The user will turn the spinner rate knob clockwise to increase and counter clockwise to decrease (1 step increments), until the spinner display digits match the least significant digits of the dispensed material weight in pounds. The user will again press the spinner rate knob to complete calibration. The liquid rate knob controls 2 MSD, the spinner rate knob controls 2 LSD.

[0091] With regards to the Product2 material ratio, - This is a ratio of the dispense rate for a product as compared to the dispense rate of the product used during the auger calibration. With regards to the Product3 ratio, - This is a ratio of the dispense rate for a given product as compared to the dispense rate of the product used during the auger calibration.

[0092] In some embodiments of the present invention the master power distribution unit and electrical interface unit 50 pertain to:

[0093] The master power distribution unit 50 will monitor inputs, provide outputs, send commands to the control panel, accept commands from the control panel, and control any slave power distribution units. Output functionality, where applicable will perform according to the hydraulic function chart on the last page. The following items describe the input and output requirements for the MPDU.

[0094] Ground Speed Input: Input voltage range will be 1 VPP to 100VPP sinusoidal or square wave input. Configurable as DC coupled sinking input, DC coupled sourcing input, and AC coupled input as defined in the calibration menu

[0095] Serial Input Port: Pins allocated on one side of the 24 pin Deutsch connector will allow for serial programming of the MPDU in the field.

[0096] Serial Output port: Pins allocated on one side of the 24-pin Deutsch connector will provide serial communications between the master and any slave devices.

[0097] Unloader Output: Provides fixed unregulated voltage source of up to 3 ampere at the unloader output pin. Refer to attached hydraulic function chart for output activation.

[0098] Spinner Output: Provides pwm regulated current source of up to 3 ampere at the spinner valve output pin. The current value is determined by the spinner rate setting at the front panel. The pwm output frequency is fixed at 100Hz.

[0099] Auger Output: Provides pwm regulated current source of up to 3 ampere at the auger output pin. The current value is determined by the auger rate setting at the front panel. The pwm output frequency is fixed at 100Hz.

[0100] Plow Flow Control Output: Provides pwm regulated current source of up to 3 ampere at the plow flow control output pin. The current value is determined by the joystick deflection angle or the flow control valve drive value as defined in the calibration menu. The pwm output frequency is fixed at 100Hz.

[0101] Liquid Motor Control Output: Provides pwm regulated current source of up to 8 ampere at the liquid motor output pins (2 required). The current value is determined by the liquid, and auger rate settings at the front panel. The pwm output frequency is determined by the liquid pwm frequency as defined in the calibration menu.

[0102] Slave Power Distribution Unit : The slave power distribution unit will receive commands from the master, and provide outputs to additional hydraulic pieces. The harness connection will determine the module's functionality as either

a plow output module or scraper output module. Output functionality, where applicable will perform according to the hydraulic function chart on the last page. The following items describe the input and output requirements for the SPDU.

[0103] Hoist Up Output / No Function: Slave module connected to plow harness provides pwm regulated current source of up to 3 ampere at the hoist up output pin. The current value is determined by the dump mode joystick deflection angle or the dump hoist valve drive value as defined in the calibration menu. The pwm output frequency is fixed at 100Hz. Slave module connected to scraper harness provides no function for this output.

[0104] Hoist Down Output / No Function: Slave module connected to plow harness provides pwm regulated current source of up to 3 ampere at the hoist down output pin. The current value is determined by the dump mode joystick deflection angle or the dump hoist valve drive value as defined in the calibration menu. The pwm output frequency is fixed at 100Hz. Slave module connected to scraper harness provides no function for this output.

[0105] Plow Down Output / Scraper Down Output: Slave module connected to plow harness provides fixed unregulated voltage source of up to 3 ampere at the plow down / scraper down output pin. Slave module connected to scraper harness provides fixed unregulated voltage source of up to 3 ampere at the plow down / scraper down output pin.

[0106] Plow Left Output / Scraper Left Output: Slave module connected to plow harness provides fixed unregulated voltage source of up to 3 ampere at the plow down or scraper down output pin. Slave module connected to scraper harness provides fixed unregulated voltage source of up to 3 ampere at the plow down / scraper down output pin.

[0107] Plow Right Output / Scraper Right Output: Slave module connected to plow harness provides fixed unregulated voltage source of up to 3 ampere at the plow down or scraper down output pin. Slave module connected to scraper harness provides fixed unregulated voltage source of up to 3 ampere at the plow down / scraper down output pin.

[0108] Plow Up Output / Scraper Up Output: Slave module connected to plow harness provides fixed unregulated voltage source of up to 3 ampere at the plow down or scraper down output pin. Slave module connected to scraper harness provides fixed unregulated voltage source of up to 3 ampere at the plow down / scraper down output pin.

[0109] Joystick or keypad pushbutton inputs will be mutually exclusive. If an attempt is made to activate more than one pushbutton on the joystick, the relevant backlight of the function mode selected will flash red to dark, and an audible beep will sound. No associated output will activate. Any involved output that was active will be turned off. If an attempt is made to activate more than one input on the keypad, the relevant keys selected will flash red to dark, and an audible beep will sound. No associated output will activate. Any involved output that was active will be turned off.

[0110] The product ratio value menu items will be used to adjust output current to the auger when the dispense material is changed. A ratio of 1:1 will apply for the material that is dispensed during calibration.

[0111] The auto mode takeoff is defined as a timer that controls the duration the auger will be set to blast when groundspeed is initially detected. This value is a calibration menu item and will range from 0-10 seconds.

[0112] Re-programming of the control panel will be accomplished using a harness connected between a PC and the control panel joystick input. Re-programming of the master and slave units will be accomplished using a DB9 to 12 pin Deustch harness connected between a PC and one of the 12 pin Deustch connectors at each module. The desired method is to update all modules through the control panel joystick input using PLC communications.

[0113] The pwm frequency of all pulse width modulated outputs will be fixed at 100Hz, except for the liquid output. The liquid pwm output will be adjustable from 50Hz to 200Hz in 50Hz increments through a menu item.

[0114] If the maximum specified current for an output is exceeded, the output will be turned off along with any associated output, and any relevant backlight at the display will flash with audible beep indicating a failure.

[0115] In some embodiments of the present invention the vehicle 20 hydraulic system pertains to:

[0116] The functions include: Front Plow 22 - Single or Double acting raise/lower; Front Plow - Double acting angle; Dump Hoist - Single or Double acting ; Auger/conveyor - Proportional Flow Control; Spinner - Proportional Flow Control; Pre-Wet - Variable Electric Motor; Valve Drive Characteristics; Valves 1-9 : 12VDC @ 1800mA/ Switched control; Valves 10&11 : 12VDC @ 2750mA/Proportional control/100 Hz PWM; (Current compensated outputs are preferred); Motor: 12VDC @ 8000mA/Proportional control/50 Hz PWM.

[0117] The system 20 functions also include: Proportional Valve/Motor Trims : Provision for trimming the minimum and maximum drive to the Auger, Spinner and Pre-Wet Motor drives; and Groundspeed Control : Provision for operation of the Auger valve drive in proportion to the vehicle speed. This is to be an open-loop servo design. The endpoints of the operating curve should be defined by the minimum and maximum trim settings for the auger drive. The slope of the curve should be controlled by the operation of the increase or decrease of the auger input control. The curve will define the relationship of Δ%Valve Drive/ΔMPH. The net effect of changing the slope will be to move the maximum valve trim endpoint from an occurrence at 45 MPH (maximum speed) to a lower MPH value.

[0118] In one embodiment, the system includes valves that operate generally as follows:

Circuit Design: The design includes load-sense communication from all work valves.

Construction Style: The valve design are preferably solenoid operated cartridge style with a common manifold. The cartridge solenoids are preferably rated IP69.

Flow Priority: There is preferably a flow priority to insure operation of the cylinder functions whenever the spreader

is operating and pump flow is critically low.

Proportional Cylinder Control: All cylinders have proportional flow control on the power sequence to afford cylinder speed control.

Pressure Relief Valves : Independent and stem adjustable pressure protection are preferably included for the manifold inlet, the spreader, the downside of all double acting cylinders and, plow angle cylinders.

Plow Lift Valves: The valves are preferably capable of four-way control and have a flow capacity sufficient for the flow rate requirements of the specific actuator. The raise side of the circuit are preferably rated for zero leakage.

Plow Angle Valves: The valves are preferably capable of four-way control and have a flow capacity sufficient for the flow rate requirements of the specific actuator. Load-locking check valves or "motor-spool" design are preferably included as to support the angling mechanism used.

Dump Hoist Valves: The valves are preferably capable of four-way control and have a flow capacity sufficient for the flow rate requirements of the specific actuator. Counter-balance control valves are preferably included..

Spreader Valves: The proportional flow control valves for the Auger/Conveyor and Spinner motors have flow capacities of 15/7 gpm respectively. These valves are preferably pressure compensated and parallel in their circuit architecture.

[0119] One embodiment of the present invention pertains to an apparatus for controlling a snowplow of a vehicle, comprising: a hydraulically actuatable snowplow mounted to the vehicle; a hydraulic actuator for moving said snowplow ; means for providing controlled hydraulic fluid which receives an actuation signal (such as a current signal) and provides hydraulic fluid to said actuator in response thereto; a computer controller which receives a command signal and produces said actuation signal in response thereto; a joystick movable in a direction over a range of positions and providing a first data signal which is proportional to the position of said joystick; and a keypad having first and second manual switches, said first switch providing a predetermined second data signal when switched, said second switch providing a predetermined third data signal when switched; wherein said first data signal, said second data signal, and said third data signal correspond to a desired rate of movement of said snowplow, and one of said first data signal, said second data signal, or said third data signal correspond to said command signal.

[0120] Yet another embodiment of the present invention pertains to the apparatus described herein which further comprises a hydraulically actuatable dump body mounted to the vehicle and movable over a second range of positions; a second hydraulic actuator for moving the dump body over the second range at a rate of movement; the electrohydraulic interface unit receiving a dump signal and providing hydraulic fluid to the second actuation in response thereto; and a selection switch providing a selection signal to the electrical interface unit, the electrical interface unit using the state of the selection switch to determine if the first data signal corresponds to movement of the dump body or movement of the snowplow.

[0121] Yet another embodiment of the present invention pertains to any of the apparatus of methods described herein wherein the electrohydraulic interface unit includes at least one proportional solenoid and at least one spool valve, the solenoid applying a force to the valve which is proportional to the actuation signal.

[0122] Yet another embodiment of the present invention pertains to any of the apparatus of methods described herein wherein the vehicle includes a DC electrical system, the actuation signal is at a frequency, and the electrical interface unit places the actuation signal on the DC electrical system.

[0123] Yet another embodiment of the present invention pertains to any of the apparatus of methods described herein which further includes a third switch adjustable by the vehicle operator and providing an output variable between high and low limits, wherein the output of the third switch establishes the second data signal.

[0124] Another embodiment of the present invention pertains to an apparatus for controlling the snow removal functions of a vehicle, comprising: a vehicle including a hydraulically actuatable first tool and a second actuatable tool; an electrohydraulic interface unit which receives an actuation signal and provides hydraulic fluid to said snowplow or said tool in response thereto; a distributed electronic control system which includes a main controller which receives a command signal and transmits a coded command signal over a plc network, a remote controls that received the coded command signal and produces said actuation signal in response thereto, said main controller receiving an identification signal and responsive to select one of said first tool or said second tool for actuation in response thereto; and a joystick movable in each of two directions over a range of positions and providing said command signal which is proportional to the position of said joystick, said joystick including a first switch and a second switch; wherein the states of said first switch and second switch provides said identification signal

[0125] Yet another embodiment of the present invention pertains to any of the apparatus or methods described herein which further comprises a hydraulically actuatable dump body and a third switch, the electrohydraulic interface unit providing hydraulic fluid to dump body, the electrical interface unit selecting one of the snowplow, tool, or dump body for actuation, and wherein the states of the first switch, second switch, and third switch provides the identification signal.

[0126] Yet another embodiment of the present invention pertains to any of the apparatus or methods described herein wherein the joystick includes a deadman switch providing a signal to the electrical interface unit corresponding to the

presence of a user of the vehicle, the electrical interface unit providing the actuation signal only if the user is present.

[0127] Yet another embodiment of the present invention pertains to any of the apparatus of methods described herein wherein the joystick includes dual redundant sensors for providing the command signal.

[0128] Yet another embodiment of the present invention pertains to any of the apparatus or methods described herein wherein the joystick is centerable in each of the two directions and the electrical interface unit is programmable to apply a deadband region to each direction.

[0129] Another embodiment of the present invention pertains to a method for controlling the snowplow of a truck, comprising: providing a truck having an actuatable snowplow actuatable in each of two directions at a variable rate of movement and a two axis controller, wherein the controller is moveable in each axis over a range of positions, the snowplow is actuatable in each direction over a range of rates of movement, and the range of positions corresponds to the range of rates; moving the snowplow in one direction at a predetermined rate in response to movement of the controller in one axis to a predetermined position; and moving the snowplow in the other direction at a predetermined rate in response to movement of the controller in the other axis to a predetermined position.

[0130] Another embodiment of the present invention pertains to a system for electronically logging the snow and ice removal functions of a vehicle, comprising: a vehicle having an electrical power system and including a snowplow hydraulically actuatable to a plurality of positions and a system for distributing a granular product on a roadway within a range of distribution rates; a first sensor providing a first signa! corresponding to the position of the snowplow, a second sensor providing a second signal corresponding to the distribution rate of the product, a third sensor providing a third signal corresponding to the position of the vehicle, and a clock providing a time signal; and electronic data capturing and computational module that receives the first signal, second signal, third signal, and time signal, the first signal and second signal being transmitted from the corresponding said sensor to said module by communication over the power system, said module using the second signal, third signal, and time signal to compute a product output rate in terms of weight of product distributed per unit distance.

[0131] Yet another embodiment of the present invention pertains to any of the apparatus or methods described herein which further comprises an automatic vehicle locating system, wherein the computed data is provided to the AVL system.

[0132] While the inventions have been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the spirit of the invention are desired to be protected.

Claims

1. An apparatus for controlling a snowplow of a vehicle, comprising:

a hydraulically actuatable snowplow mounted to the vehicle and movable over a range of positions;
a hydraulic actuator for moving said snowplow over the range at a rate of movement;
an electrohydraulic interface unit which receives an actuation signal and provides hydraulic fluid to said actuator in response thereto;
an electrical interface unit which receives a command signal and produces said actuation signal in response thereto;
a joystick movable in a direction over a range of positions and providing a first data signal which is proportional to the position of said joystick; and
a keypad having first and second manual switches, said first switch providing a fixed predetermined second data signal when switched, said second switch providing a fixed predetermined third data signal when switched;

wherein said first data signal, said second data signal, and said third data signal correspond to a desired rate of movement of said snowplow, and one of said first data signal, said second data signal, or said third data signal correspond to said command signal.

2. The apparatus of claim 1 wherein said keypad produces said actuation signal in response to one or the other of said joystick or said keypad.

3. The apparatus of claim 1 wherein if said joystick remains centered for a more than a predetermined period time, the electrical interface unit automatically corresponds said first signal to the rate of movement of said snowplow.

4. An apparatus for controlling the snow removal functions of a vehicle, comprising:

a vehicle including a hydraulically actuatable snowplow and a second actuatable tool;
an electrohydraulic interface unit which receives an actuation signal and provides hydraulic fluid to said snowplow or said tool in response thereto ;
an electrical interface unit which receives a command signal and produces said actuation signal in response thereto, said interface unit receiving an identification signal and responsive to select one of said snowplow or said tool for actuation in response thereto; and
a joystick movable in each of two directions over a range of positions and providing said command signal which is proportional to the position of said joystick, said joystick including a first switch and a second switch;

wherein the states of said first switch and second switch provides said identification signal.

5. The apparatus of claim 4 wherein said command signal is proportional to the rate of movement of said snowplow or said tool.

6. The apparatus of claim 4 wherein said electrical interface unit responds to said identification signal only if said joystick is generally centered.

7. A method for controlling the snowplow of a truck, comprising:

providing a truck having an actuatable snowplow actuatable in each of two directions at a variable rate of movement and a two axis controller, wherein the controller is moveable in each axis over a range of positions, the snowplow is actuatable in each direction over a range of rates of movement, and the range of positions corresponds to the range of rates;
moving the snowplow in one direction at a predetermined rate in response to movement of the controller in one axis to a predetermined position; and
moving the snowplow in the other direction at a predetermined rate in response to movement of the controller in the other axis to a predetermined position.

8. The method of claim 7 which further comprises:

providing the truck with a dump body actuatable in a direction over a range of rates of dumping movement, and the range of positions is capable of corresponding to the range of rates of dumping movement;
selecting the range of positions to correspond to the range of rates of dumping movements; and
preventing the range of positions from corresponding to the range of rates of snowplow movement.

9. A system for electronically logging the snow and ice removal functions of a vehicle, comprising:

a vehicle having an electrical power system and including a snowplow hydraulically actuatable to a plurality of positions and a system for distributing a granular product on a roadway within a range of distribution rates;
a first sensor providing a first signal corresponding to the position of the snowplow, a second sensor providing a second signal corresponding to the distribution rate of the product, a third sensor providing a third signal corresponding to the position of the vehicle, and a clock providing a time signal; and
electronic data capturing and computational module that receives the first signal, second signal, third signal, and time signal, the first signal and second signal being transmitted from the corresponding said sensor to said module by communication over the power system, said module using the second signal, third signal, and time signal to compute a product output rate in terms of weight of product distributed per unit distance.

10. The system of claim 9 which further comprises a repeatedly removable non-volatile memory unit, wherein the computed data is provided to the unit.

FIG. 1

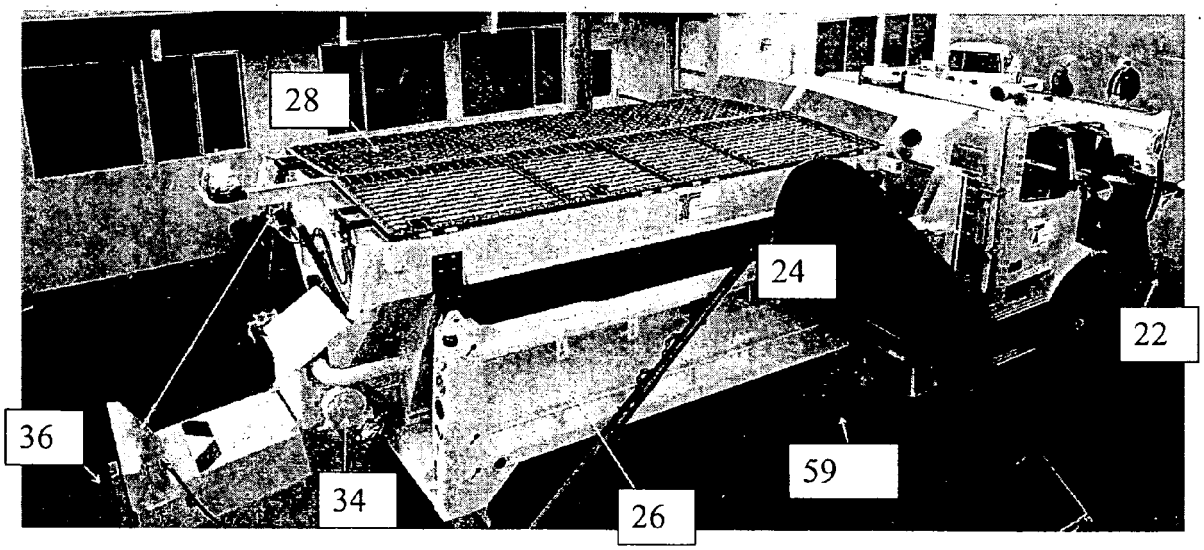


FIG. 2

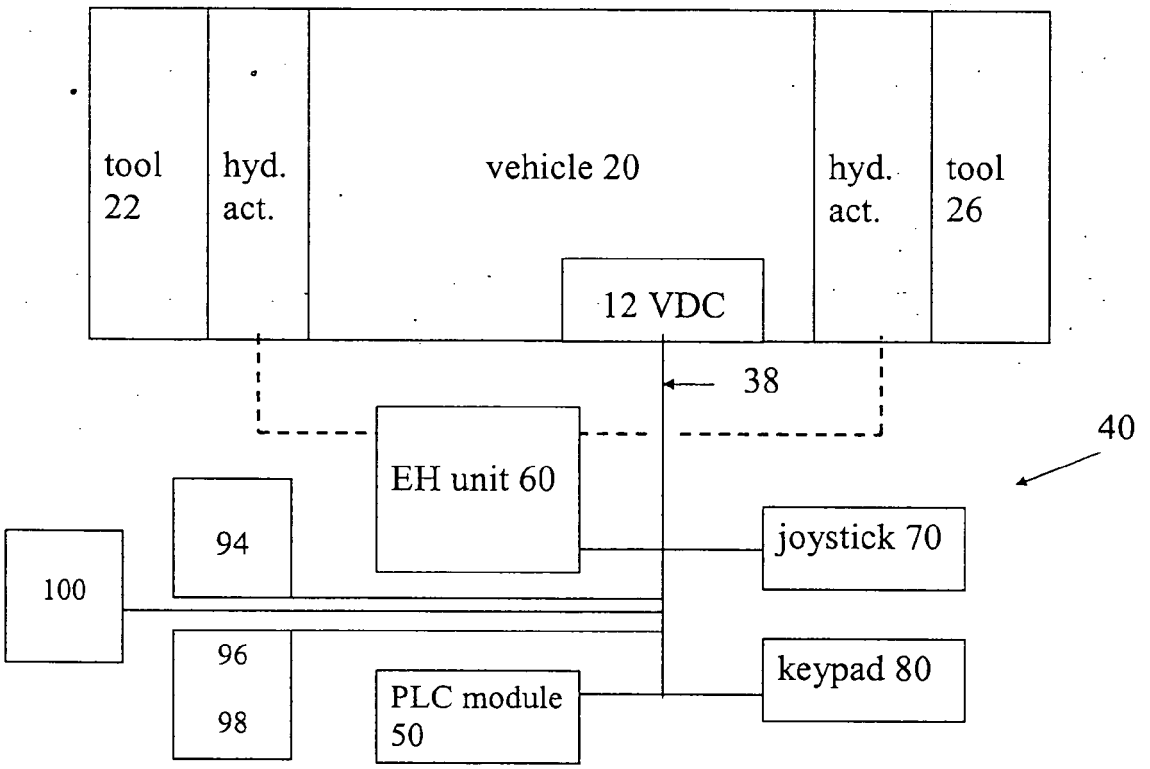

tool
22
hyd.
act.
vehicle 20
hyd.
act.
tool
26
12 VDC
38
40
EH unit 60
94
joystick 70
100
96
98
PLC module
50
keypad 80

FIG. 3

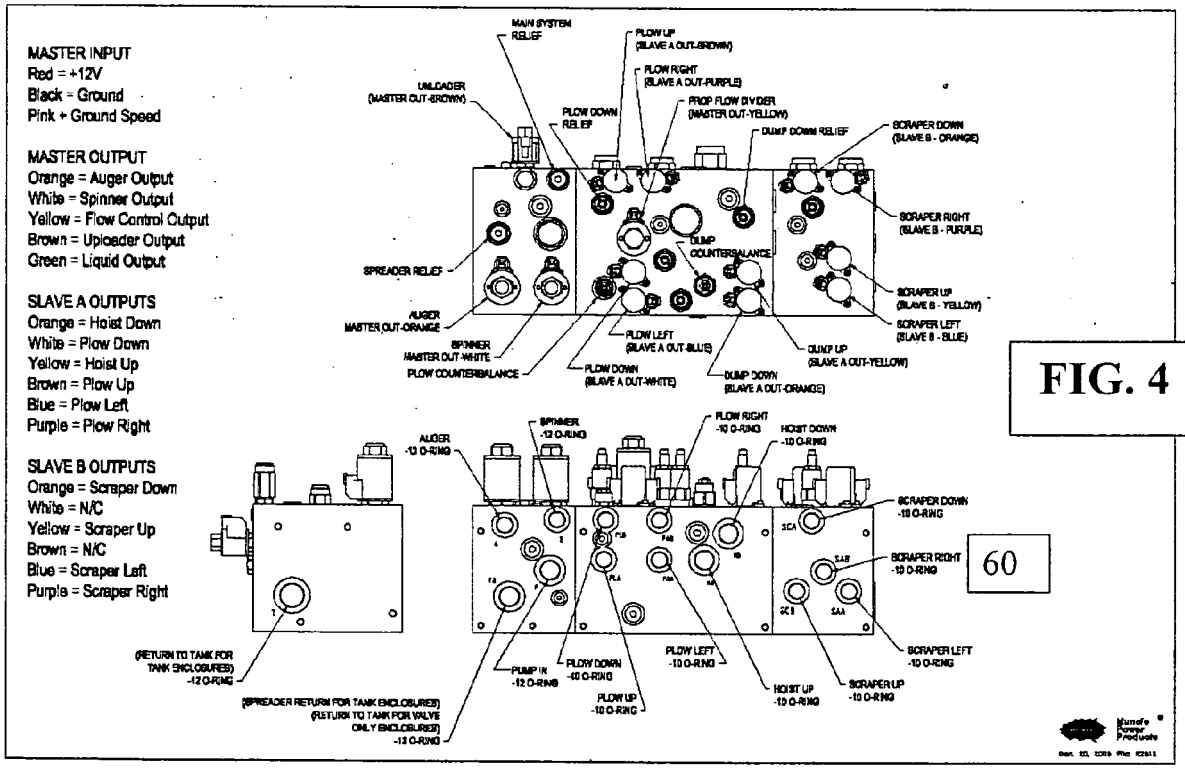

MASTER INPUT
Red = +12V
Black = Ground
Pink = Ground Speed
MASTER OUTPUT
Orange = Auger Output
White = Spinner Output
Yellow = Flow Control Output
Brown = Upicader Output
Green = Liquid Output
SLAVE A OUTPUTS
Orange = Hoist Down
White = Plow Down
Yellow = Hoist Up
Brown = Plow Up
Blue = Plow Left
Purple = Plow Right
SLAVE B OUTPUTS
Orange = Scraper Down
White = N/C
Yellow = Scraper Up
Brown = N/C
Blue = Scraper Left
Purple = Scraper Right
MAIN SYSTEM RELIEF
PLOW UP (SLAVE A OUT-BROWN)
FLOW RIGHT (SLAVE A OUT-PURPLE)
UNLOADER (MASTER OUT-BROWN)
PLOW DOWN RELIEF
PROP FLOW DIVIDER (MASTER OUT-YELLOW)
DUMP DOWN RELIEF
SCRAPER DOWN (SLAVE B - ORANGE)
SCRAPER RIGHT (SLAVE B - PURPLE)
SPREADER RELIEF
DUMP COUNTERBALANCE
SCRAPER UP (SLAVE B - YELLOW)
AUGER MASTER OUT-ORANGE
SCRAPER LEFT (SLAVE B - BLUE)
SPINNER MASTER OUT-WHITE
PLOW LEFT (SLAVE A OUT-BLUE)
PLOW COUNTERBALANCE
PLOW DOWN (SLAVE A OUT-WHITE)
DUMP UP (SLAVE A OUT-YELLOW)
DUMP DOWN (SLAVE A OUT-ORANGE)
AUGER -12 O-RING
SPINNER -12 O-RING
FLOW RIGHT -10 O-RING
HOIST DOWN -10 O-RING
SCRAPER DOWN -10 O-RING
SCRAPER RIGHT -10 O-RING
SCRAPER LEFT -10 O-RING
(RETURN TO TANK FOR TANK ENCLOSURES) -12 O-RING
(SPREADER RETURN FOR TANK ENCLOSURES) (RETURN TO TANK FOR VALVE ONLY ENCLOSURES) -12 O-RING
PUMP IN -12 O-RING
PLOW DOWN -10 O-RING
PLOW UP -10 O-RING
PLOW LEFT -10 O-RING
HOIST UP -10 O-RING
SCRAPER UP -10 O-RING
60

FIG. 4

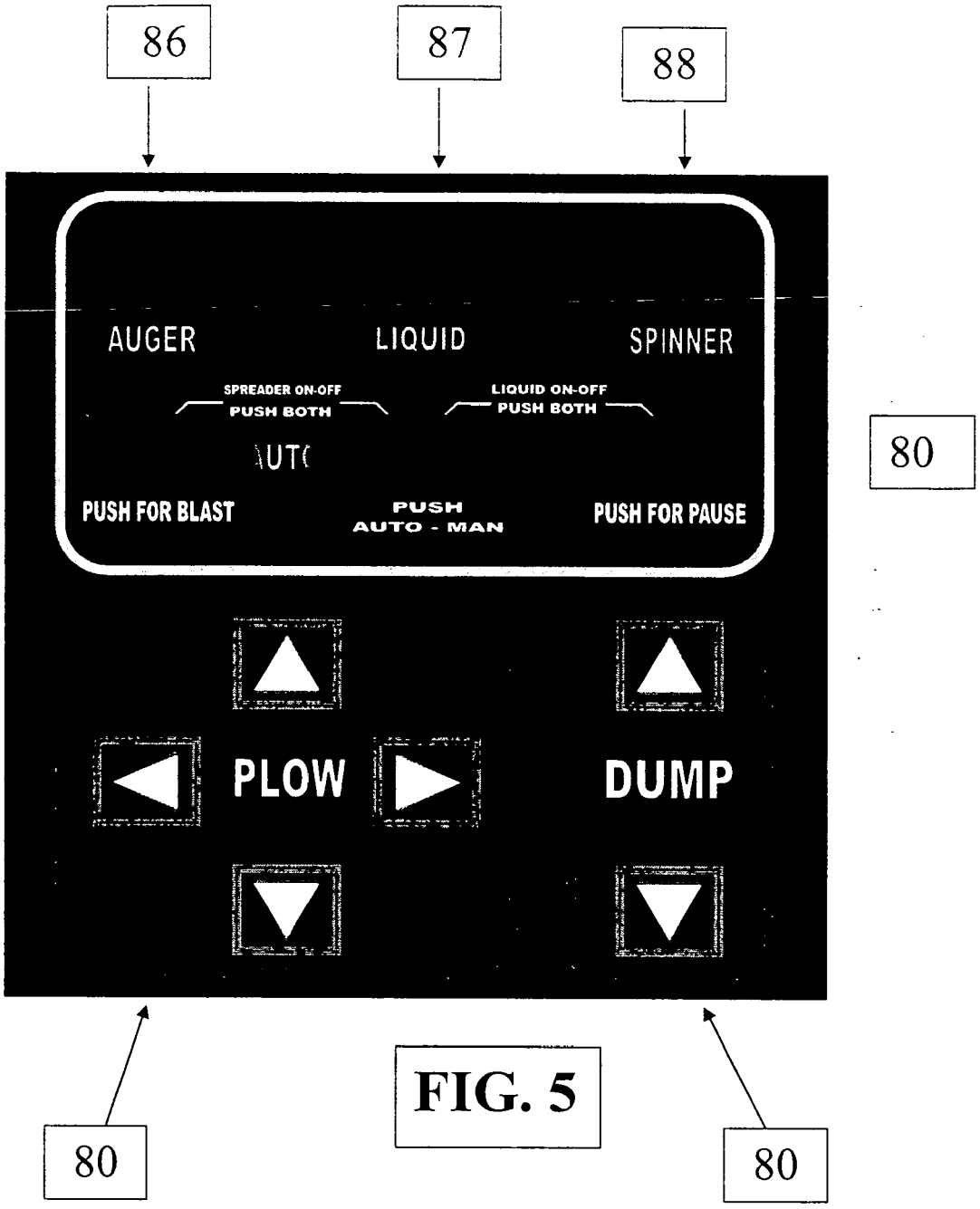
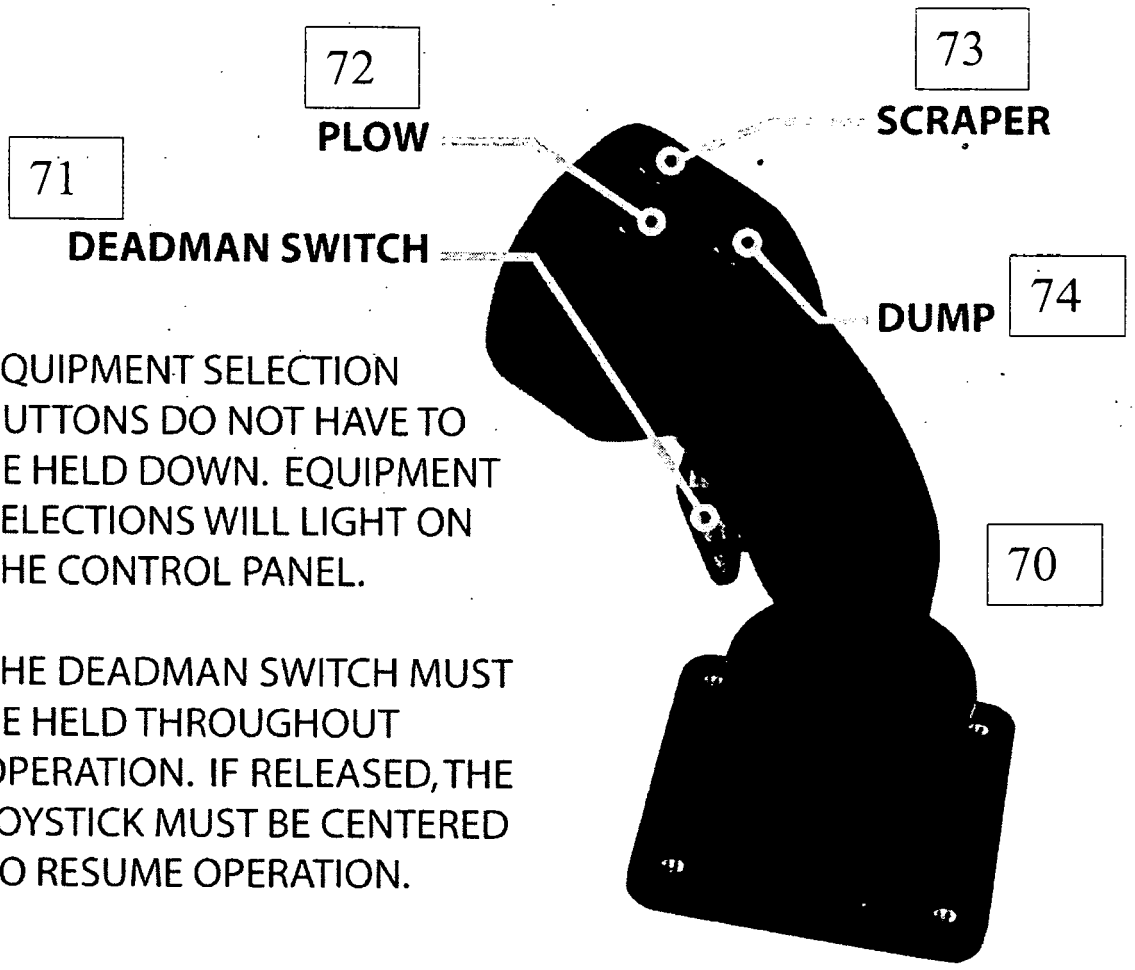

86
87
88
AUGER
LIQUID
SPINNER
SPREADER ON-OFF
PUSH BOTH
LIQUID ON-OFF
PUSH BOTH
AUTO
PUSH FOR BLAST
PUSH
AUTO - MAN
PUSH FOR PAUSE
80
PLOW
DUMP
80
80

FIG. 5

FIG. 6


72
PLOW
73
SCRAPER
71
DEADMAN SWITCH
DUMP
74
70
EQUIPMENT SELECTION BUTTONS DO NOT HAVE TO BE HELD DOWN. EQUIPMENT SELECTIONS WILL LIGHT ON THE CONTROL PANEL.
THE DEADMAN SWITCH MUST BE HELD THROUGHOUT OPERATION. IF RELEASED, THE JOYSTICK MUST BE CENTERED TO RESUME OPERATION.

	Valve 1	Valve 2	Valve 3	Valve 4	Valve 5	Valve 6	Valve 7	Valve 8	Valve 9	Valve 10	Valve 11	Motor
Plow Up	SA/DA				SA/DA							
Plow Down	DA					SA/DA	SA/DA					
Plow Left	DA		DA									
Plow Right	DA			DA								
Dump Up		SA/DA						SA/DA				
Dump Down	SA	DA							SA/DA			
Auger										Auger		
Spinner											Spinner	
Pre-Wet												Motor

FIG. 7

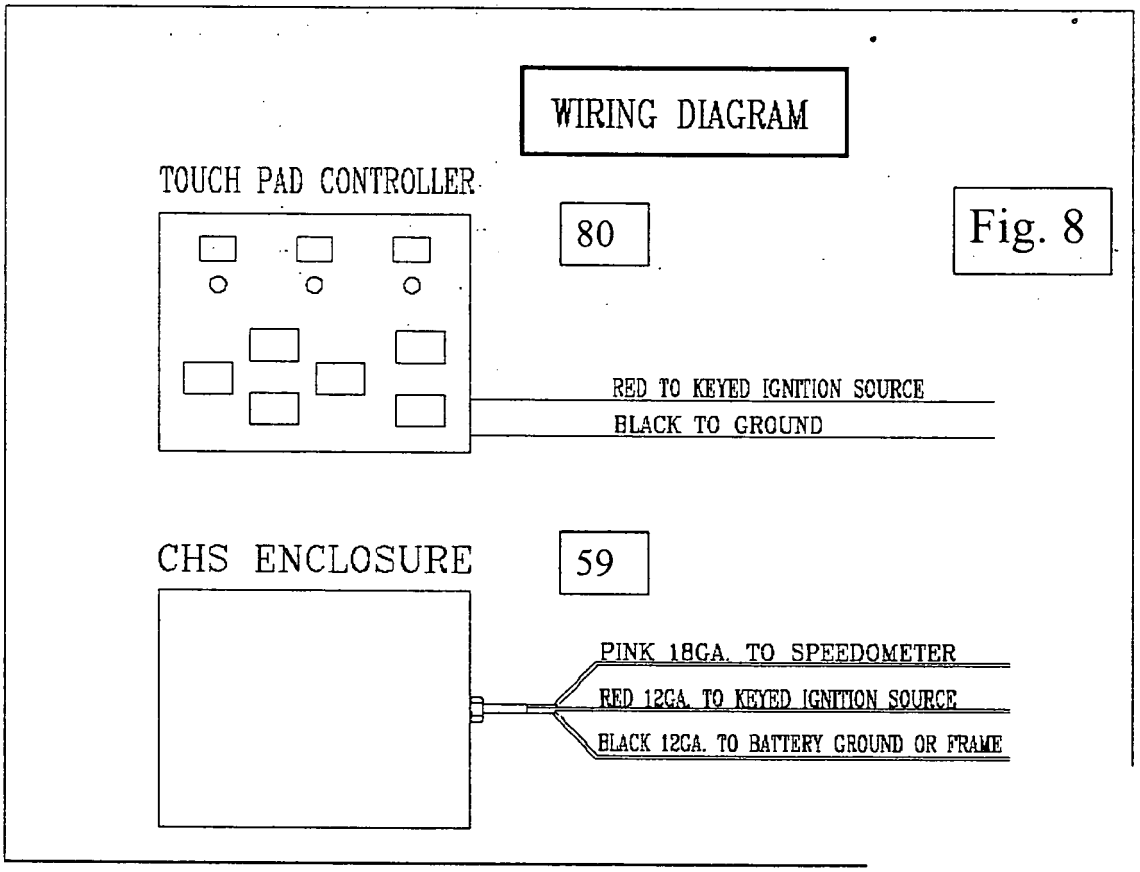

WIRING DIAGRAM
TOUCH PAD CONTROLLER
80
RED TO KEYED IGNITION SOURCE
BLACK TO GROUND
CHS ENCLOSURE
59
PINK 18GA. TO SPEEDOMETER
RED 12GA. TO KEYED IGNITION SOURCE
BLACK 12GA. TO BATTERY GROUND OR FRAME

Fig. 8

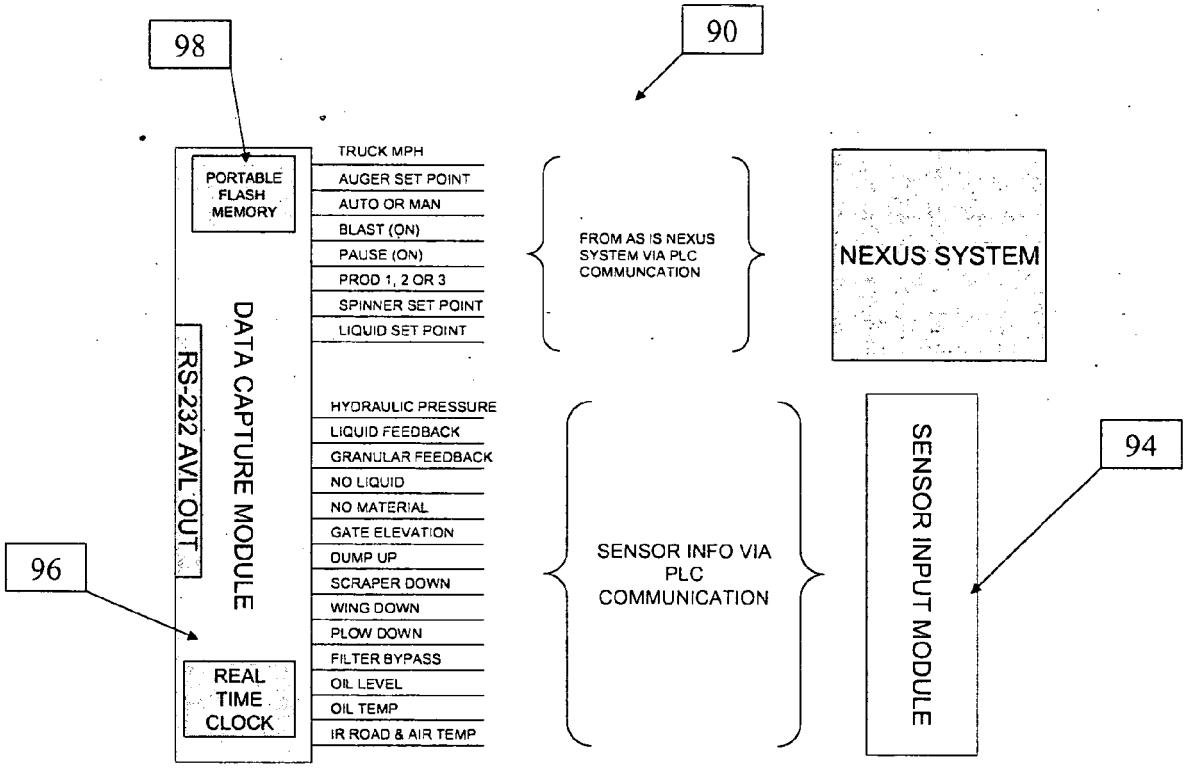

98
90
PORTABLE FLASH MEMORY
DATA CAPTURE MODULE
RS-232 AVL OUT
REAL TIME CLOCK
96
TRUCK MPH
AUGER SET POINT
AUTO OR MAN
BLAST (ON)
PAUSE (ON)
PROD 1, 2 OR 3
SPINNER SET POINT
LIQUID SET POINT
HYDRAULIC PRESSURE
LIQUID FEEDBACK
GRANULAR FEEDBACK
NO LIQUID
NO MATERIAL
GATE ELEVATION
DUMP UP
SCRAPER DOWN
WING DOWN
PLOW DOWN
FILTER BYPASS
OIL LEVEL
OIL TEMP
IR ROAD & AIR TEMP
FROM AS IS NEXUS SYSTEM VIA PLC COMMUNCATION
NEXUS SYSTEM
SENSOR INFO VIA PLC COMMUNICATION
SENSOR INPUT MODULE
94

FIG. 9

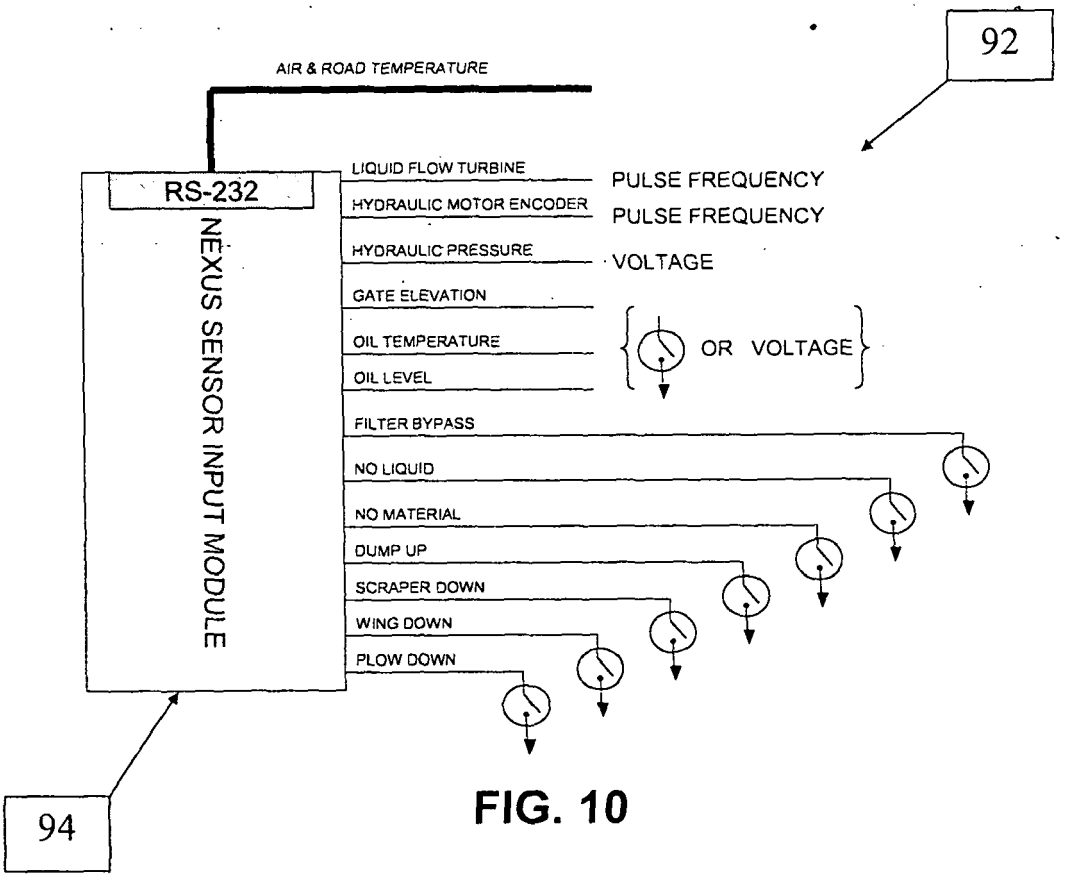

92
AIR & ROAD TEMPERATURE
RS-232
NEXUS SENSOR INPUT MODULE
LIQUID FLOW TURBINE
PULSE FREQUENCY
HYDRAULIC MOTOR ENCODER
PULSE FREQUENCY
HYDRAULIC PRESSURE
VOLTAGE
GATE ELEVATION
OIL TEMPERATURE
OR VOLTAGE
OIL LEVEL
FILTER BYPASS
NO LIQUID
NO MATERIAL
DUMP UP
SCRAPER DOWN
WING DOWN
PLOW DOWN
94

FIG. 10

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 88090107 P **[0001]**