Chapter 4

Electrical

JACOBSEN
A Textron Company

Specifications

Test and Adjustment Specifications

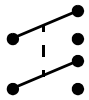
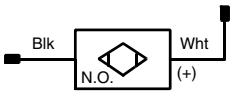
Specifications		
Resistance Across Solenoid Coil—Raise Solenoid Coil at 68°F	ohms	7.0 ± 10%
Resistance Across Solenoid Coil—Lower Solenoid Coil at 68° F	ohms	6.0 ± 10%
Resistance Across Solenoid Coil—Mow Solenoid Coil at 68° F	ohms	9.8 ± 10%
Fuel Level Sender Resistance Between Terminals at Full Position	ohms	Between 26 and 35
Fuel Level Sender Resistance Between Terminals at Empty Position	ohms	Between 211 and 286

Theory and Diagnostic Information

Electrical Component Symbols

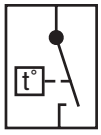
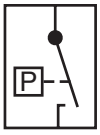
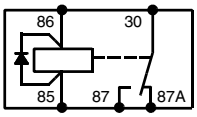
The following symbols are used in the electrical schematics to represent various electrical components.

Switches[1]

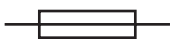
Single Pole, Single Throw (SPST) 	Double Pole, Single Throw (DPST) 
Single Pole, Double Throw (SPDT) 	Double Pole, Double Throw (DPDT) 
Proximity Switch 	

1 The sample switch symbols shown are just a few of the many switch configurations. Switches are designated by the number of "poles" (circuits controlled) and "throws" (actuator positions). Unless otherwise specified, switches are shown in the "Normally Open" (N.O.) position.

Switching Devices

Temperature Switch 	Pressure Switch 
Relay 	

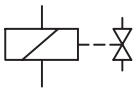
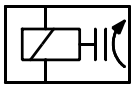
Circuit Protection Devices

Fuse 	Circuit Breaker 

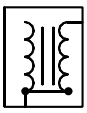
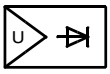
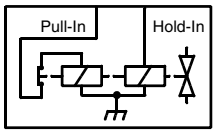
Motors and Generating Devices

Electric Motors (may also include “AC” or “DC.”) 	Stator 
Alternator 	

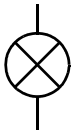
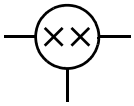
Actuating Devices

Solenoid Valve 	PTO Clutch 

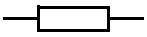
Engine-Related Devices

Ignition Coil 	Spark Plug 
Regulator 	Fuel Shutoff Solenoid 

Lights

Single-Element Light 	Dual-Element Light 

Miscellaneous Symbols

Enclosure (cabinet, housing, etc.) 	Wires (crossing but not connected) 
Ground (to earth) 	Wiring Connections 
Ground (to chassis) 	Coil
Direct Current (DC) (as shown on an oscilloscope)	Battery 
Alternating Current (AC) (as shown on an oscilloscope) 	Diode 
Resistor 	Pin and Socket Connector 

Electrical Schematic Component Identification

Electrical components shown in the main schematic are identified with an alpha-numeric callout. All electrical components shown in the electrical schematic are listed below.

- A1—Control Module (See Figure 4-2.)
- A2—Cruise Control Module (See Figure 4-4.)
- B1—Engine Oil Pressure Switch (See Figure 4-1.)
- B2—Hydraulic Oil Level Switch (See Figure 4-3.)
- B3—Hydraulic Filter Pressure Switch (See Figure 4-2.)
- B4—Engine Temperature Sensor (See Figure 4-4.)
- B5—Fuel Level Sensor (See Figure 4-4.)
- E1—Left Work Light (See Figure 4-4.)
- E2—Right Work Light (See Figure 4-4.)
- F1—50A Circuit Breaker (See Figure 4-1.)
- G1—Battery (See Figure 4-1.)
- G2—Alternator (See Figure 4-1.)
- H1—Engine Temperature Gauge (See Figure 4-4.)
- H2—Fuel Gauge (See Figure 4-4.)
- H3—Hour Meter (See Figure 4-4.)
- H4—Horn (See Figure 4-1.)
- H5—Engine Oil Pressure Light (See Figure 4-1.)
- H6—Hydraulic Oil Level Light (See Figure 4-3.)
- H7—Alternator Light (See Figure 4-1.)
- H8—Glow Plug Light (See Figure 4-1.)
- H9—Hydraulic Filter Pressure Light (See Figure 4-1.)
- J1—Control Module Connector (See Figure 4-2.)
- J2—Control Module Connector (See Figure 4-2.)
- J3—Control Module Connector (See Figure 4-2.)
- J4—Control Module Connector (See Figure 4-2.)
- K1—Start Relay (See Figure 4-1.)
- K2—Glow Plug Relay (See Figure 4-1.)
- M1—Starter Motor (See Figure 4-1.)
- M2—Fuel Pump (See Figure 4-1.)
- R1—Glow Plugs (See Figure 4-1.)
- S1—Key Switch (See Figure 4-1.)
- S2—Horn Switch (See Figure 4-1.)
- S3—Seat Switch (See Figure 4-3.)
- S4—Neutral Proximity Switch (See Figure 4-3.)
- S5—Park Brake Proximity Switch (See Figure 4-3.)
- S6—Cruise Control Switch (See Figure 4-4.)
- S7—Raise/Lower Switch (See Figure 4-3.)
- S8—Traction Control Switch (See Figure 4-3.)
- S9—Work Light Switch (See Figure 4-4.)
- S10—Mow Switch (See Figure 4-3.)
- Y1—Fuel Shutoff Solenoid (See Figure 4-1.)
- Y3—Mow Solenoid (See Figure 4-3.)
- Y4—Raise Solenoid (See Figure 4-3.)
- Y5—Lower Solenoid (See Figure 4-3.)
- Y6—Cruise Control Magnet (See Figure 4-4.)

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Electrical Schematic

See Figures 4-1 through 4-4.

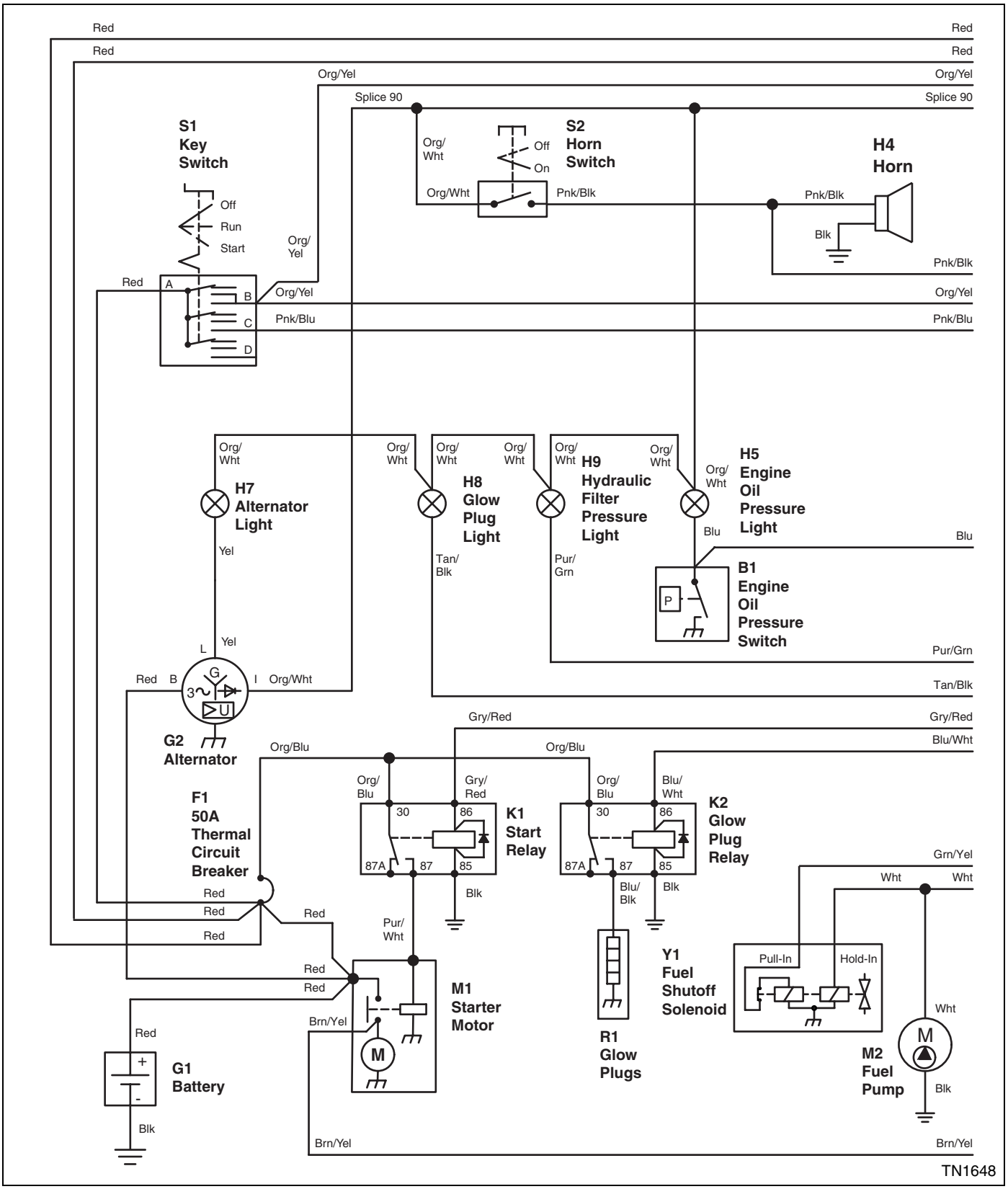

Figure 4-1

Electrical Schematic
Continued

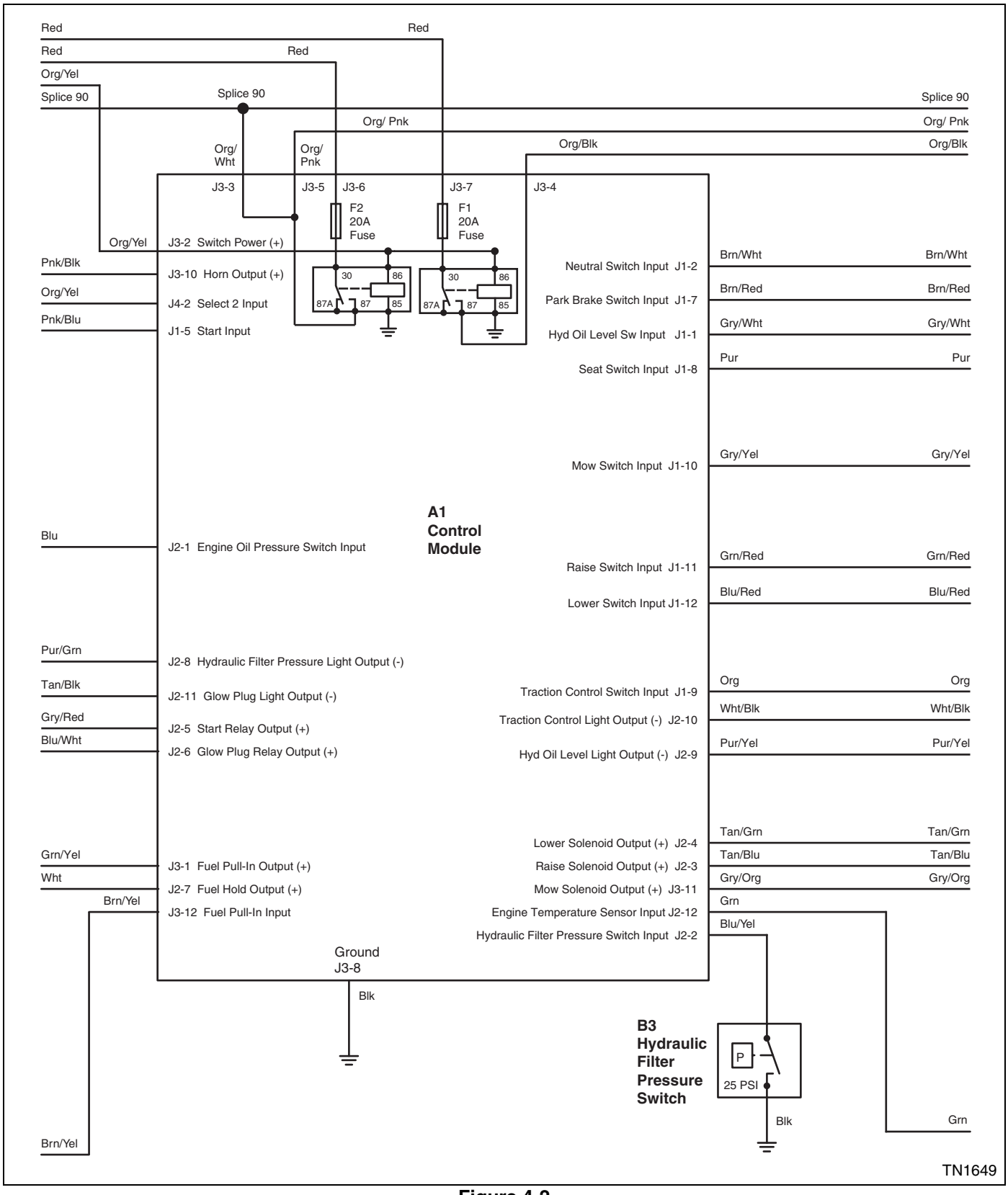

Figure 4-2

Electrical Schematic
Continued

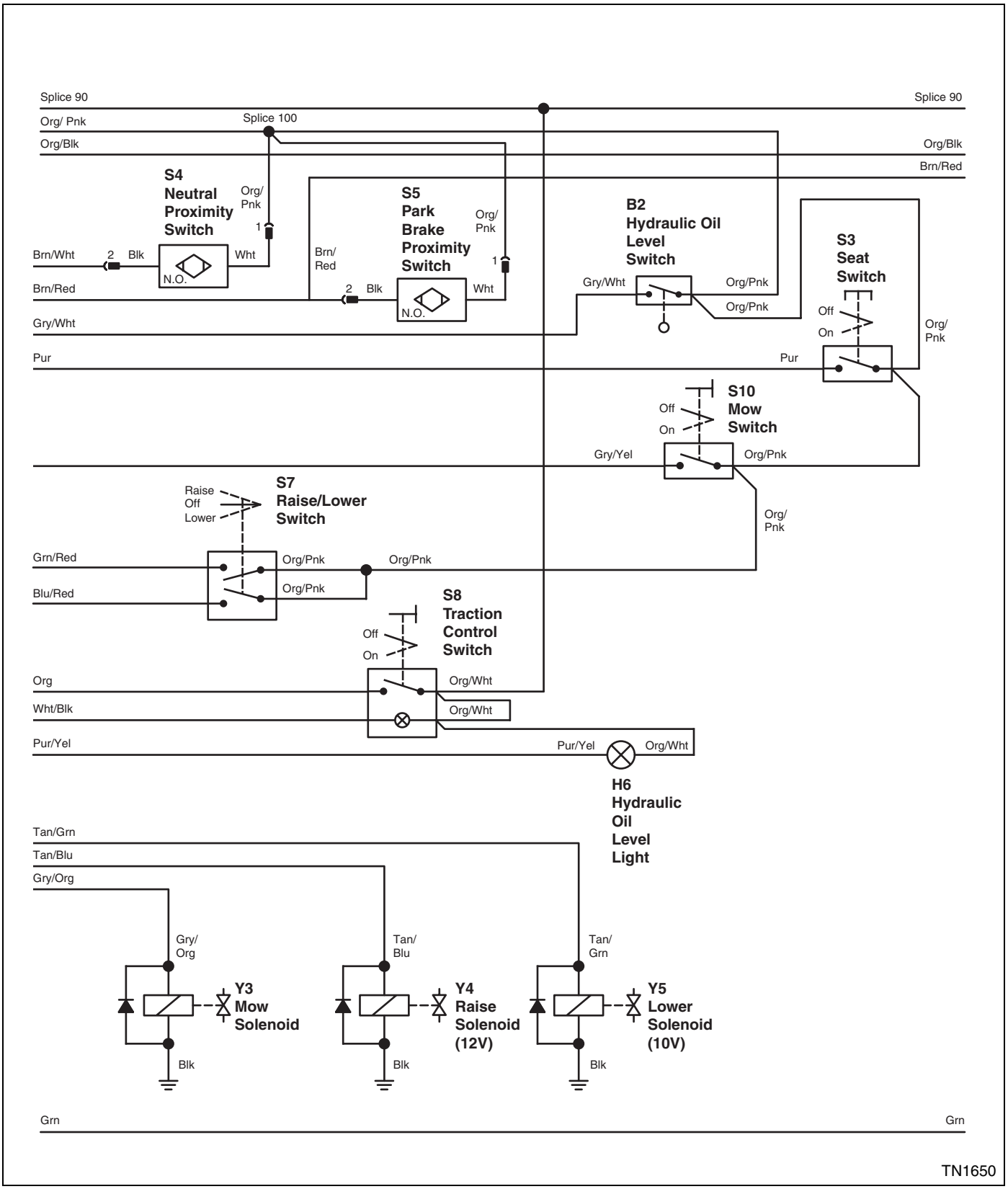

Figure 4-3

Electrical Schematic
Continued

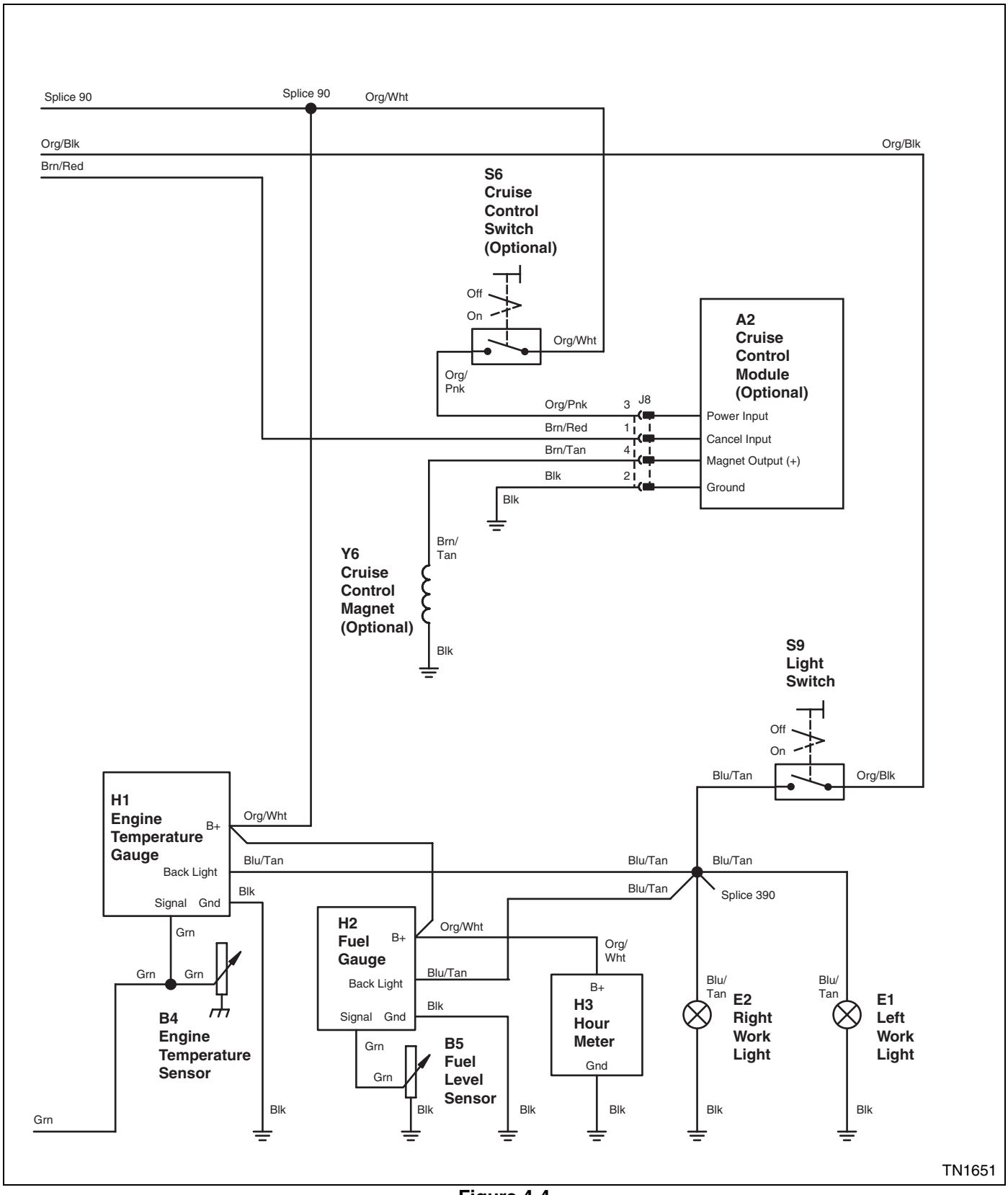

Figure 4-4

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Theory of Operation and Sub Circuit Schematics

Power Circuit—Theory of Operation

Unswitched Power Circuit

Unswitched power is available from the battery positive terminal to the starting motor battery terminal and then from the starting motor battery terminal to 50 amp thermal circuit breaker battery terminal. Unswitched power is available through the 50 amp thermal circuit breaker to start and glow plug relays terminal 30.

Unswitched power is available from 50 amp thermal circuit breaker battery terminal to key switch terminal A and control module terminals J3-6 and J3-7.

Switched Power Circuit

When the key switch is turned to the run position, voltage is provided from key switch terminal B to control module switch power input terminal J3-2, powering up the control module and energizing the two internal switched power relays.

Voltage is also provided from key switch terminal B to control module select 2 input terminal J4-2, activating the input. With the select 2 input activated, the control module selects the software program for this machine. This allows the control module to be used in more than one machine.

With the internal switched power relays energized, switched power is available from switched power relay terminal 87 to control module terminal J3-3. Switched power is available from control module terminal J3-3 to splice 90. From splice 90, switched power is available to the following components:

- Engine oil pressure light
- Horn switch
- Alternator terminal I
- Traction control switch
- Cruise control switch (optional)
- Engine temperature gauge B+ terminal

Switched power is also provided from the engine oil pressure light to the hydraulic filter pressure light and then from the hydraulic filter pressure light to the glow plug light. From the glow plug light to the alternator light.

Splice 90 also provides switched power to the following:

- Traction control switch
- Engine temperature gauge B+ terminal
- Cruise control switch (optional)

Switched power is also provided from engine temperature gauge to the fuel gauge B+ terminal and then from the fuel gauge B+ terminal to the hour meter. With switched power provided to the gauges and hour meter, the gauges start to operate and the hour meter starts logging hours.

With the internal switched power relays energized, switched power is available from switched power relay terminal 87 to control module terminal J3-5. Switched power is available from control module terminal J3-5 to splice 100. From splice 100, switched power is available to the following components:

- Neutral proximity
- Park brake proximity switch
- Hydraulic oil level switch

Switched power is also provided from hydraulic oil level switch to the seat switch and then from the seat switch to the mow switch. Switched power is provided from the mow switch to the raise-lower switch.

With the internal switched power relays energized, switched power is also available from switched power relay terminal 87 to control module terminal J3-4. Switched power is available from control module terminal J3-4 to the light switch. Twenty amp fuses F1 and F2 provide protection to the switched power circuit.

Power Circuit Schematic

See Figures 4-5 through 4-8.

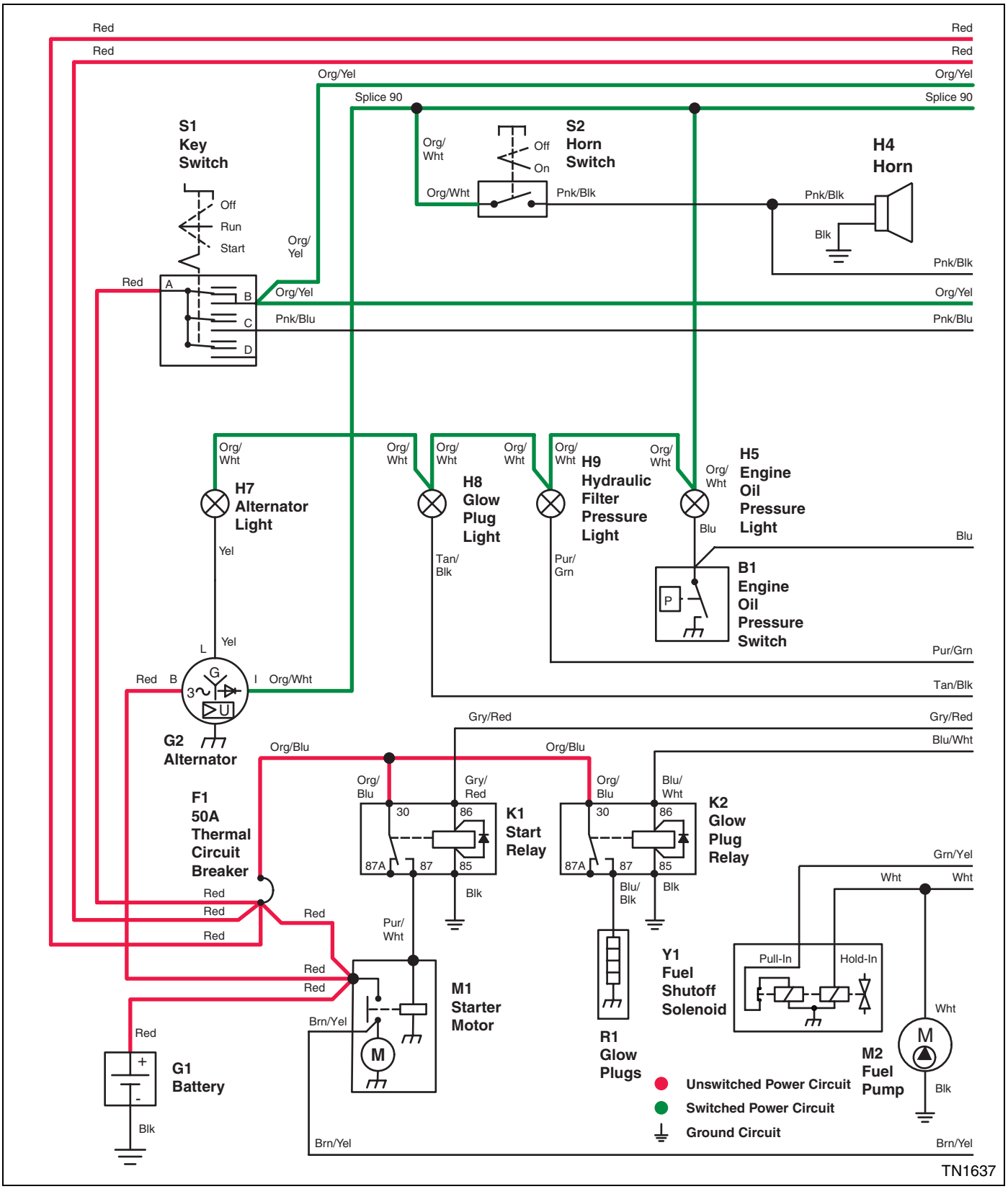

Figure 4-5

Power Circuit Schematic Continued

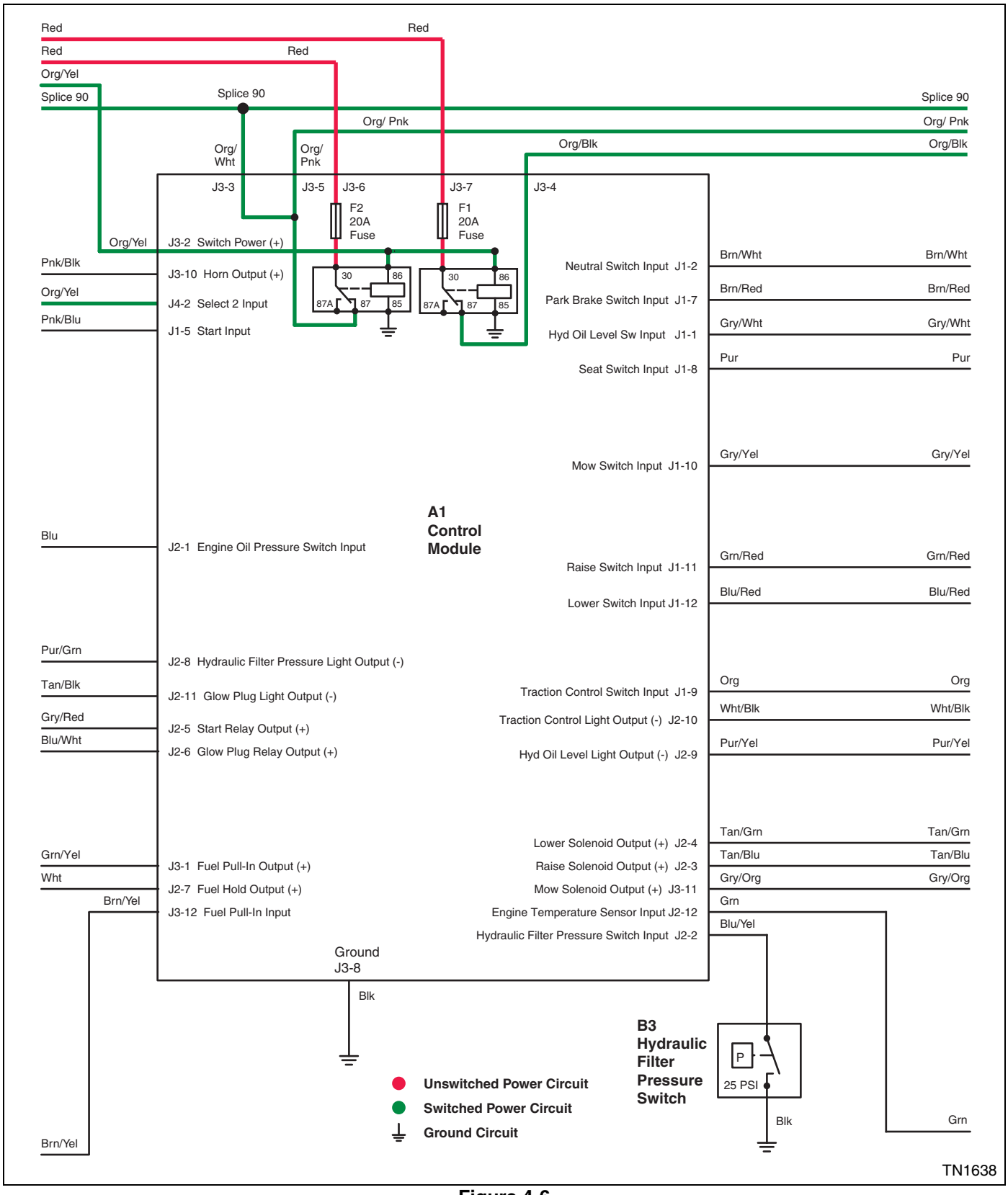

Figure 4-6

Power Circuit Schematic Continued

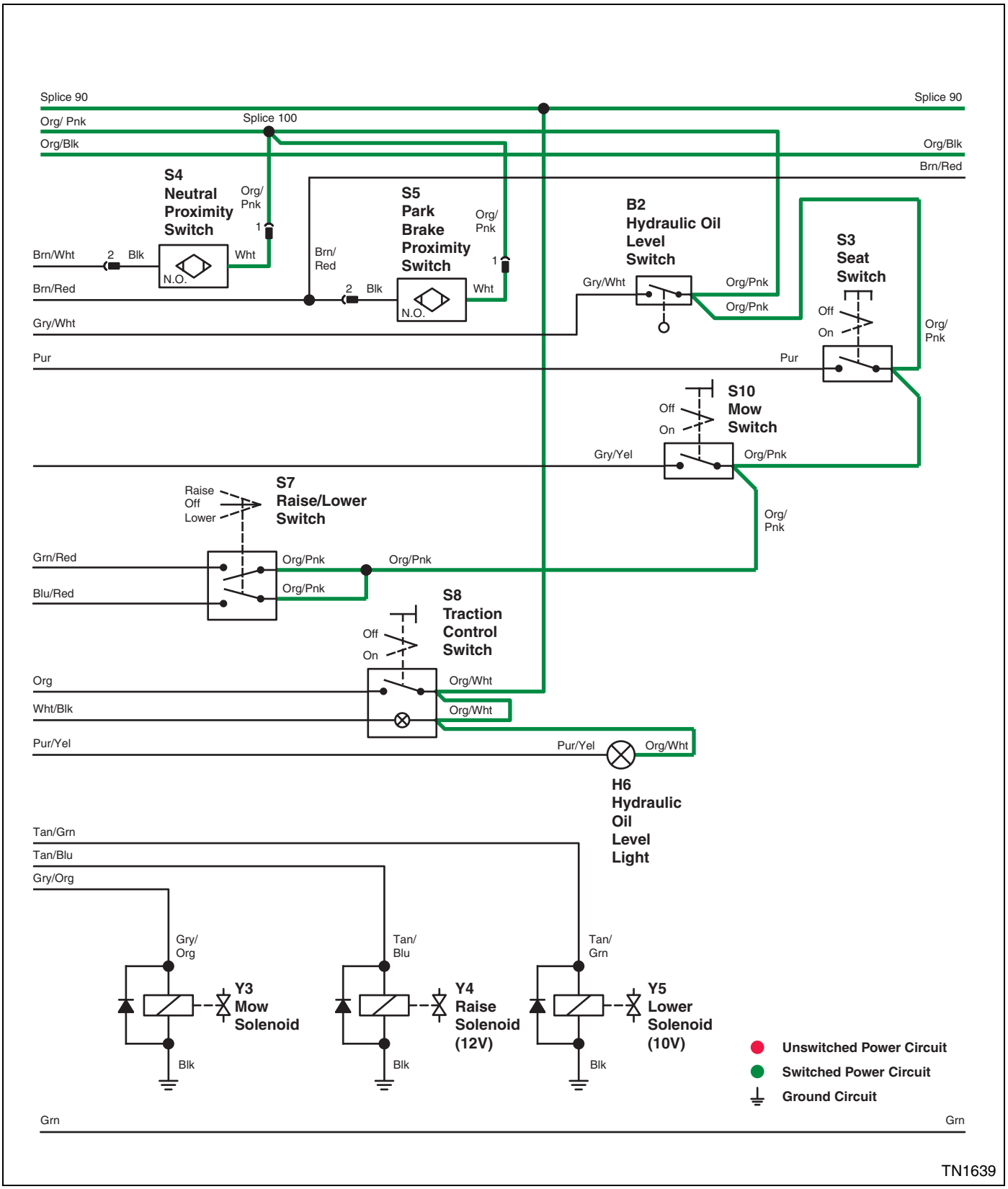

Figure 4-7

Power Circuit Schematic Continued

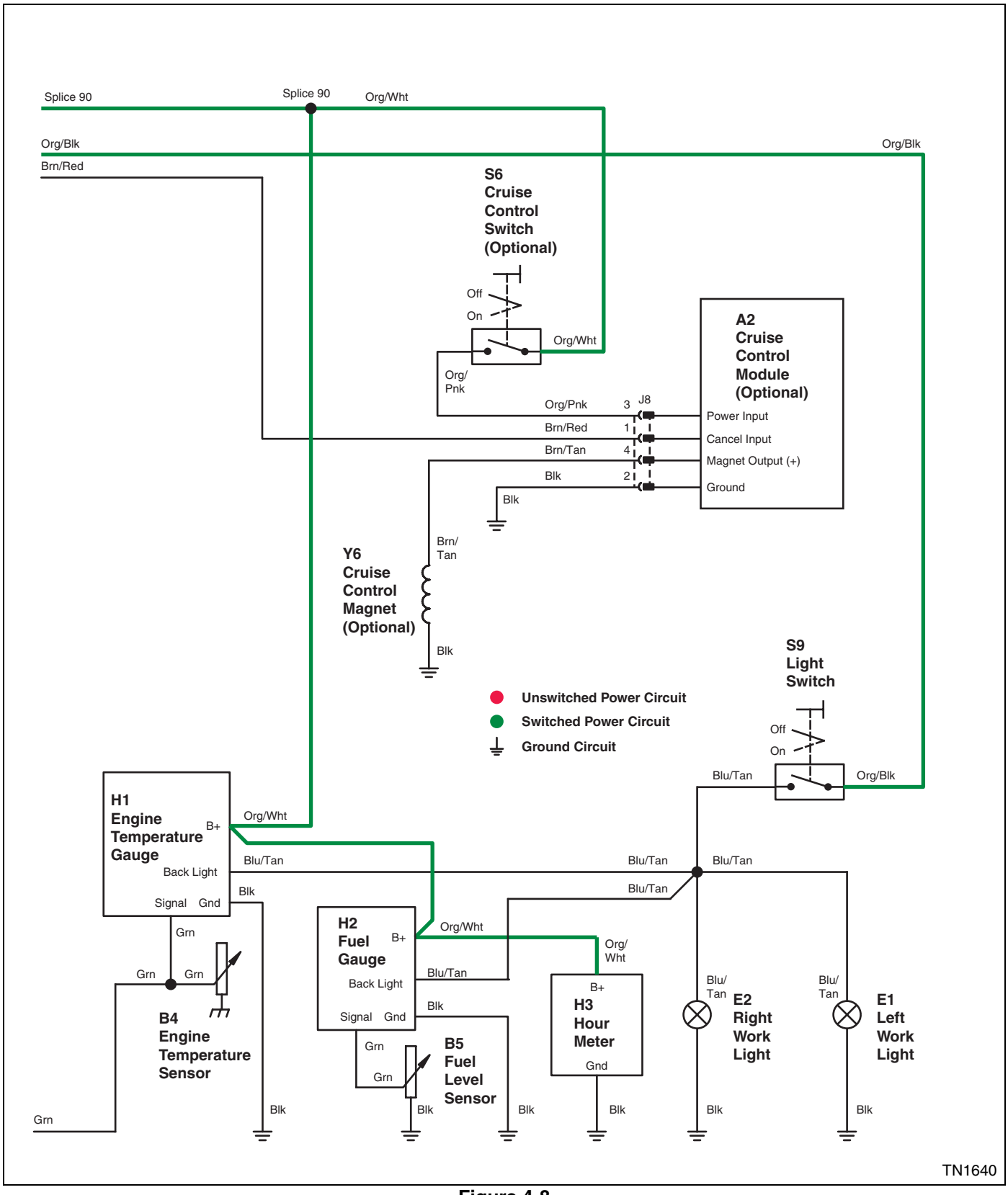

Figure 4-8

Charging Circuit—Theory of Operation

Power Circuit

Unswitched power is available from the battery positive terminal to the starting motor battery terminal and then from the starting motor battery terminal to 50 amp thermal circuit breaker battery terminal.

Unswitched power is available from 50 amp thermal circuit breaker battery terminal to key switch terminal A and control module terminal J3-6.

When the key switch is turned to the run position, voltage is provided from key switch terminal B to control module switch power input terminal J3-2, powering up the control module and energizing the internal switched power relay.

Voltage is also provided from key switch terminal B to control module select 2 input terminal J4-2, activating the input. With the select 2 input activated, the control module selects the software program for this machine. This allows the control module to be used in more than one machine.

With the internal switched power relay energized, switched power is available from switched power relay terminal 87 to control module terminal J3-3. Switched power is available from control module terminal J3-3 to splice 90. From splice 90, switched power is available to the engine oil pressure light. Switched power is available from the engine oil pressure light to the hydraulic filter pressure light and then from the hydraulic filter pressure light to the glow plug light. From the glow plug light to the alternator light.

Charging Circuit

With the engine running and the key switch in the run position, splice 90 provides voltage to the alternator field terminal, exciting the alternator. With the alternator field terminal excited, the alternator produces three-phase alternating current (AC). The AC current is rectified by internal diodes and direct current (DC) is available to the internal voltage regulator.

When the battery voltage is low, current flows from the voltage regulator to the battery, charging the battery. When the battery is fully charged, the regulator stops providing current to the battery.

With the engine running, and when the voltage regulator detects low output voltage from the alternator, the voltage regulator provides a ground to the alternator light, turning on the light.

Charging Circuit Schematic

See Figure 4-9.

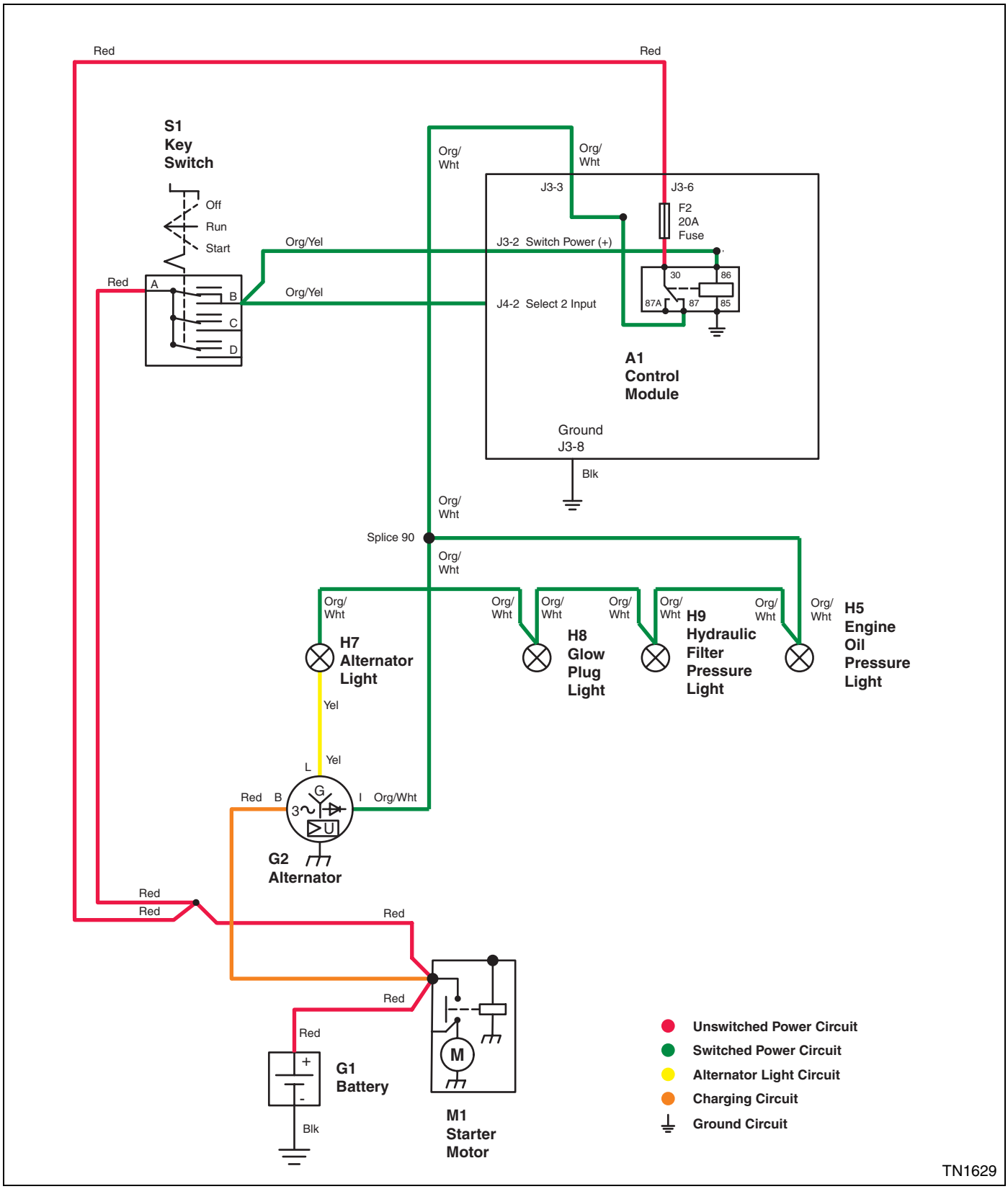

Figure 4-9

Start and Glow Plug Circuit—Theory of Operation

Power Circuit

Unswitched power is available from the battery positive terminal to the starting motor battery terminal and then from the starting motor battery terminal to 50 amp thermal circuit breaker battery terminal. Unswitched power is available through the 50 amp thermal circuit breaker to start and glow plug relays terminal 30.

Unswitched power is available from 50 amp thermal circuit breaker battery terminal to key switch terminal A and control module terminal J3-6.

When the key switch is turned to the run position, voltage is provided from key switch terminal B to control module switch power input terminal J3-2, powering up the control module and energizing the internal switched power relay.

Voltage is also provided from key switch terminal B to control module select 2 input terminal J4-2, activating the input. With the select 2 input activated, the control module selects the software program for this machine. This allows the control module to be used in more than one machine.

With the internal switched power relay energized, switched power is available from switched power relay terminal 87 to control module terminal J3-3. Switched power is available from control module terminal J3-3 to splice 90. From splice 90, switched power is available to the engine oil pressure light. Switched power is available from the engine oil pressure light to the hydraulic filter pressure light and then from the hydraulic filter pressure light to the glow plug light.

With the internal switched power relay energized, switched power is available from switched power relay terminal 87 to control module terminal J3-5. Switched power is available from control module terminal J3-5 to splice 100.

From splice 100, switched power is available to the park brake and neutral proximity switches.

With the key switch in the run position, the control module performs a control panel lamp check for approximately 4 seconds. At the same time the control module performs a horn test. During the test the horn will chirp six times.

Start and Glow Plug Circuits

To start and operate the engine with the operator off or on the seat, the mow switch must be in the off position and the following interlock switches must be activated:

- Park brake proximity switch
- Neutral proximity switch

With the brake pedal in the locked position, the brake pedal linkage is brought near the magnetic target zone of the park brake proximity switch, activating the switch. With the switch activated, voltage is provided from the proximity switch to control module park brake switch input terminal J1-7, activating the input.

With the traction pedal in the neutral position, the traction pedal linkage is brought near the magnetic target zone of the neutral proximity switch, activating the switch. With the switch activated, voltage is provided from the proximity switch to control module neutral switch input terminal J1-2 activating the input.

With the interlock switch inputs satisfied, control module fuel hold output terminal J2-7 provides voltage to the fuel shutoff solenoid hold-in coil, energizing the coil. Voltage is also provided from fuel hold output terminal to the fuel pump, turning on the pump.

When the key switch is momentarily turned to the start position, the control module activates the glow plug circuit. The control module activates the glow plug circuit between 1-6 seconds depending on the coolant temperature. The control module will not allow engine cranking until the glow plug circuit has timed out.

The key switch can be held in the start position and the control module will activate the start circuit after the glow circuit times out.

With the key switch in the start position, voltage is provided from key switch terminal C to control module start input terminal J1-5, activating the input. With the start input activated, the control module activates the glow plug circuit.

To activate the glow plug circuit, control module glow plug relay output terminal J2-6 provides voltage to glow plug relay terminal 86, energizing the relay. With the relay energized, voltage is provided from glow plug relay terminal 87 to the glow plugs, heating the glow plugs. Control module glow plug light output terminal J2-11 provides a ground to the glow plug light, turning on the light.

To activate the start circuit, control module start relay output terminal J2-5 provides voltage to start relay terminal 86, energizing the relay. With the relay energized, voltage is provided from start relay terminal 87 to the starter solenoid, energizing the solenoid. With the starter solenoid energized, voltage is provided from the starter solenoid contacts to the starter motor, engaging the motor. The control module will only allow the start circuit to operate for a maximum of 10 seconds.

With the starter solenoid energized, voltage is also provided from the starter solenoid contacts to control module fuel pull-in input terminal, activating the input. With the fuel pull-in input activated, control module fuel pull-in output terminal J3-12 provides voltage to the fuel shutoff solenoid pull-in coil, energizing the coil. With the pull-in coil energized, the solenoid plunger retracts. When the solenoid plunger is fully retracted, an internal switch opens the pull-in coil circuit. This prevents extended activation of the high current pull-in coil. The hold-in coil keeps the solenoid plunger in the retracted position until it is de-energized.

With the solenoid plunger retracted, fuel is allowed to flow and as the starter motor cranks the engine, the engine starts operating.

Start and Glow Plug Circuit Schematic

See Figures 4-10 through 4-11.

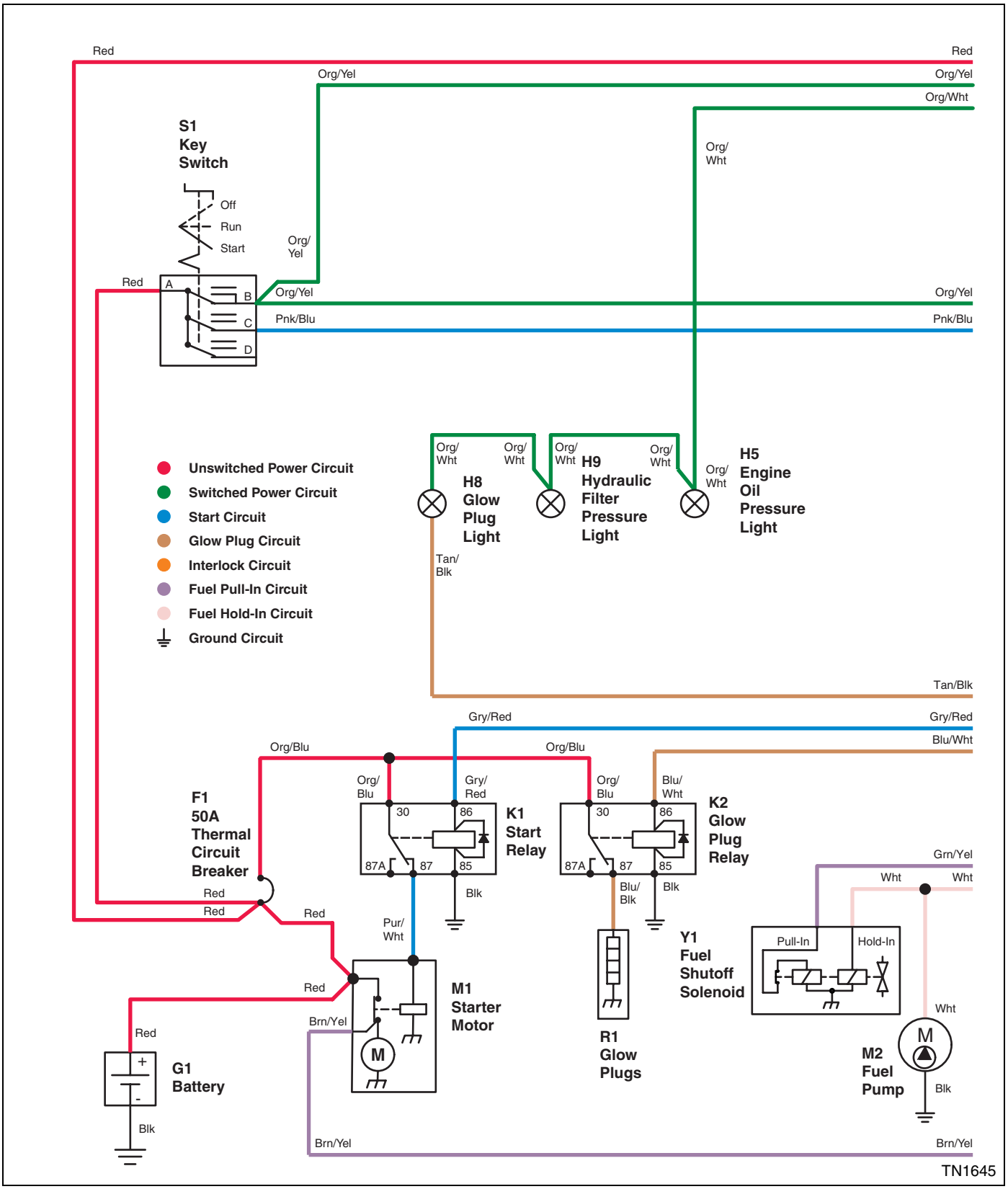

Figure 4-10

Start and Glow Plug Circuit Schematic Continued

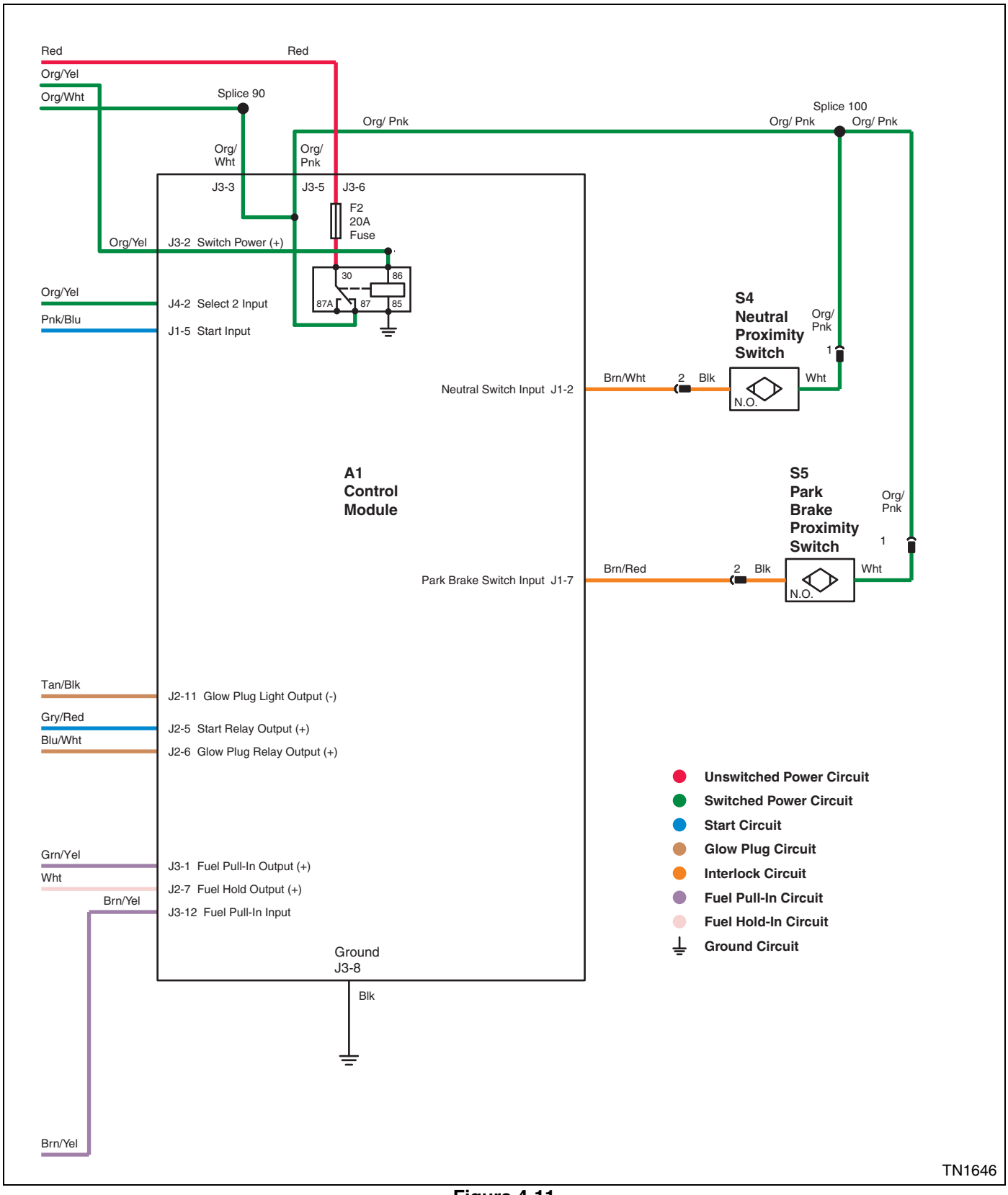

Figure 4-11

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Run Circuit—Theory of Operation

Power Circuit

Unswitched power is available from the battery positive terminal to the starting motor battery terminal and then from the starting motor battery terminal to 50 amp thermal circuit breaker battery terminal.

Unswitched power is available from 50 amp thermal circuit breaker battery terminal to key switch terminal A and control module terminal J3-6.

When the key switch is turned to the run position, voltage is provided from key switch terminal B to control module switch power input terminal J3-2, powering up the control module and energizing the internal switched power relay.

Voltage is also provided from key switch terminal B to control module select 2 input terminal J4-2, activating the input. With the select 2 input activated, the control module selects the software program for this machine. This allows the control module to be used in more than one machine.

With the internal switched power relay energized, switched power is available from switched power relay terminal 87 to control module terminal J3-5. Switched power is available from control module terminal J3-5 to splice 100.

From splice 100, switched power is available to the park brake and neutral proximity switches.

With the key switch in the run position, the control module performs a control panel lamp check for approximately 4 seconds. At the same time the control module performs a horn test. During the test the horn will chirp six times.

Run Circuit–On Seat

When the operator is on the seat, the seat switch contacts close. With the seat switch contacts closed, voltage is provided to control module seat switch input terminal J1-8, activating the input. With the input activated, the control module allows the engine to continue to operate when the park brake is released.

With the seat switch input activated, control module fuel hold-in output terminal J2-7 continues to provide voltage to the fuel shutoff hold-in coil, keeping the fuel shutoff solenoid plunger retracted. With the solenoid plunger retracted, fuel continues to flow to the engine. Voltage is also provided from fuel hold output terminal to the fuel pump and the pump continues to operate.

The control module will de-energize the fuel shutoff solenoid if the following should occur:

- After initially starting the machine, and if the operator should depress the traction pedal with the park brake locked.
- If the operator should leave the seat with the park brake in the released position.

The control module will de-energize the fuel shutoff solenoid approximately 1 second after the seat switch contacts open. The time delay is to compensate for seat bounce when operating the machine over rough terrain.

When the operator stops moving the machine and locks the park brake, the control module will sound the horn to alert the operator that the park brake pedal is set when the traction pedal is cycled. There is a 2 second delay before the control module activates the horn.

Run Circuit–Off Seat

Before leaving the seat, the mow switch must be in the off position and the following interlock switches must be activated:

- Park brake proximity switch
- Neutral proximity switch

With the brake pedal in the locked position, the brake pedal linkage is brought near the magnetic target zone of the park brake proximity switch, activating the switch. With the switch activated, voltage is provided from the proximity switch to control module park brake switch input terminal J1-7, activating the input.

With the traction pedal in the neutral position, the traction pedal linkage is brought near the magnetic target zone of the neutral proximity switch, activating the switch. With the switch activated, voltage is provided from the proximity switch to control module neutral switch input terminal J1-2 activating the input.

Note: The proximity switch is a solid state switch and will have approximately 2—3 voltage drop across the switch when activated.

With the interlock switch inputs satisfied, control module fuel hold output terminal J2-7 continues to provide voltage to the fuel shutoff solenoid hold-in coil, allowing the engine to continue to operate when the operator leaves the seat. Voltage is also provided from fuel hold output terminal to the fuel pump and the pump continues to operate.

Run Circuit Schematic—On Seat

See Figure 4-12.

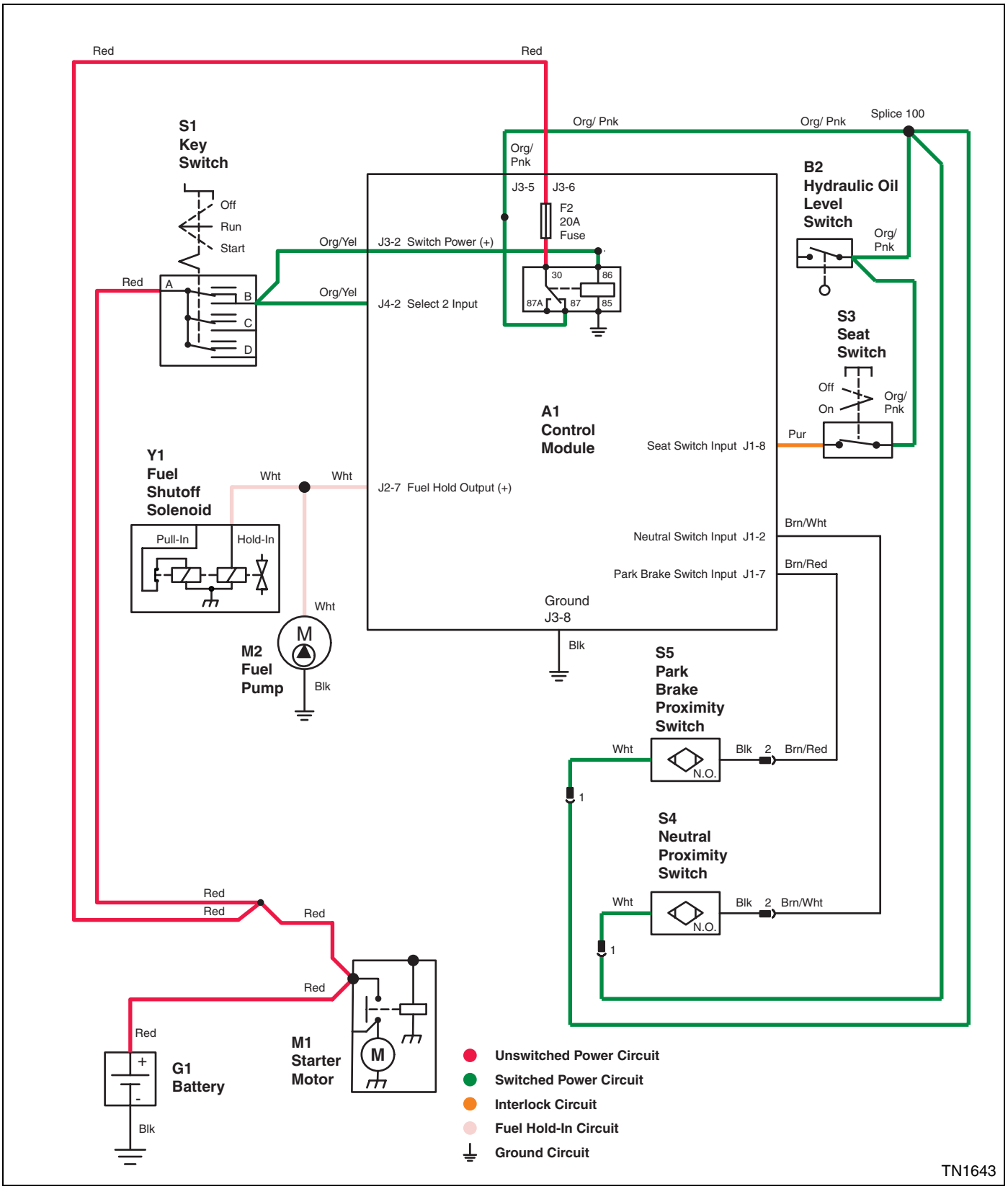

Figure 4-12

Run Circuit Schematic—Off Seat

See Figure 4-13.

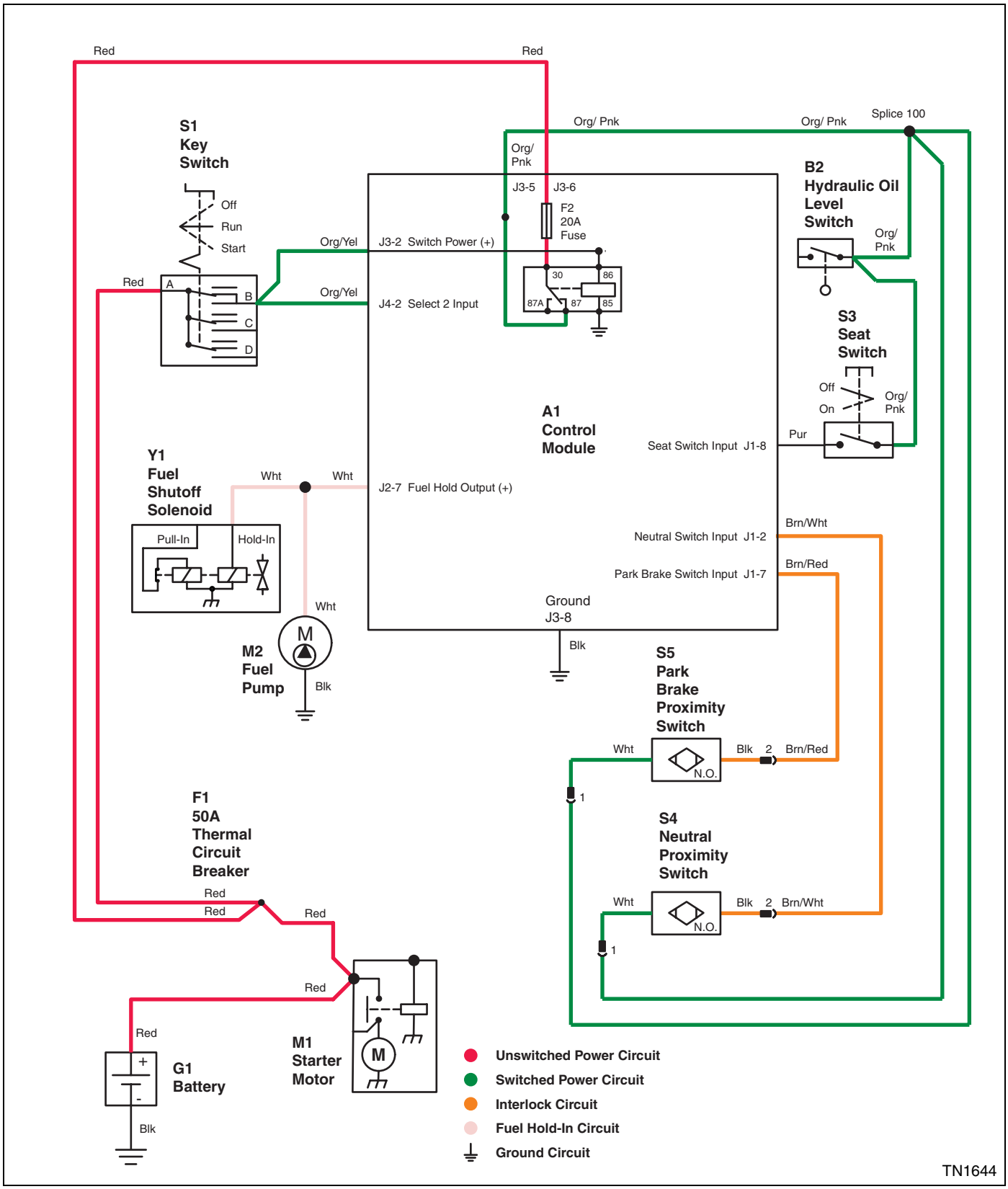

Figure 4-13

Raise/Lower Circuit—Theory of Operation

Power Circuit

Unswitched power is available from the battery positive terminal to the starting motor battery terminal and then from the starting motor battery terminal to 50 amp thermal circuit breaker battery terminal.

Unswitched power is available from 50 amp thermal circuit breaker battery terminal to key switch terminal A and control module terminals J3-6.

When the key switch is turned to the run position, voltage is provided from key switch terminal B to control module switch power input terminal J3-2, powering up the control module and energizing the internal switched power relay.

Voltage is also provided from key switch terminal B to control module select 2 input terminal J4-2, activating the input. With the select 2 input activated, the control module selects the software program for this machine. This allows the control module to be used in more than one machine.

With the internal switched power relay energized, switched power is available from switched power relay terminal 87 to control module terminal J3-5. Switched power is available from control module terminal J3-5 to splice 100. From splice 100, switched power is available to the Hydraulic oil level switch.

Switched power is available from hydraulic oil level switch to the seat switch and then from the seat switch to the mow switch. Switched power is available from the mow switch to the raise-lower switch.

Raise Circuit

When the raise/lower switch is placed in raise position, voltage is provided from the raise switch contacts to control module raise switch input terminal J1-11, activating the input. With the input activated, current flows from control module raise solenoid output terminal J2-3 to the raise solenoid, energizing the solenoid. With the solenoid energized, the cutting units will continue to rise until the raise/lower switch is released, or until the cutting units reach their end of travel.

Lower Circuit

When the raise/lower switch is placed in lower position, voltage is provided from the lower switch contacts to control module lower switch input terminal J1-12, activating the input. With the input activated, current flows from control module lower solenoid output terminal J2-4 to the lower solenoid, energizing the solenoid. With the solenoid energized, the cutting units are lowered. The control module continues to energize the lower solenoid until the raise/lower switch is released.

Note: While mowing the raise/lower function will be in “one touch crosscut” mode, meaning the raise/lower lever only needs to be tapped to move the cutting units to a pre-determined position. When not mowing the raise/lower lever must be held until the cutting units reach the desired position.

Raise Circuit Schematic

See Figure 4-14.

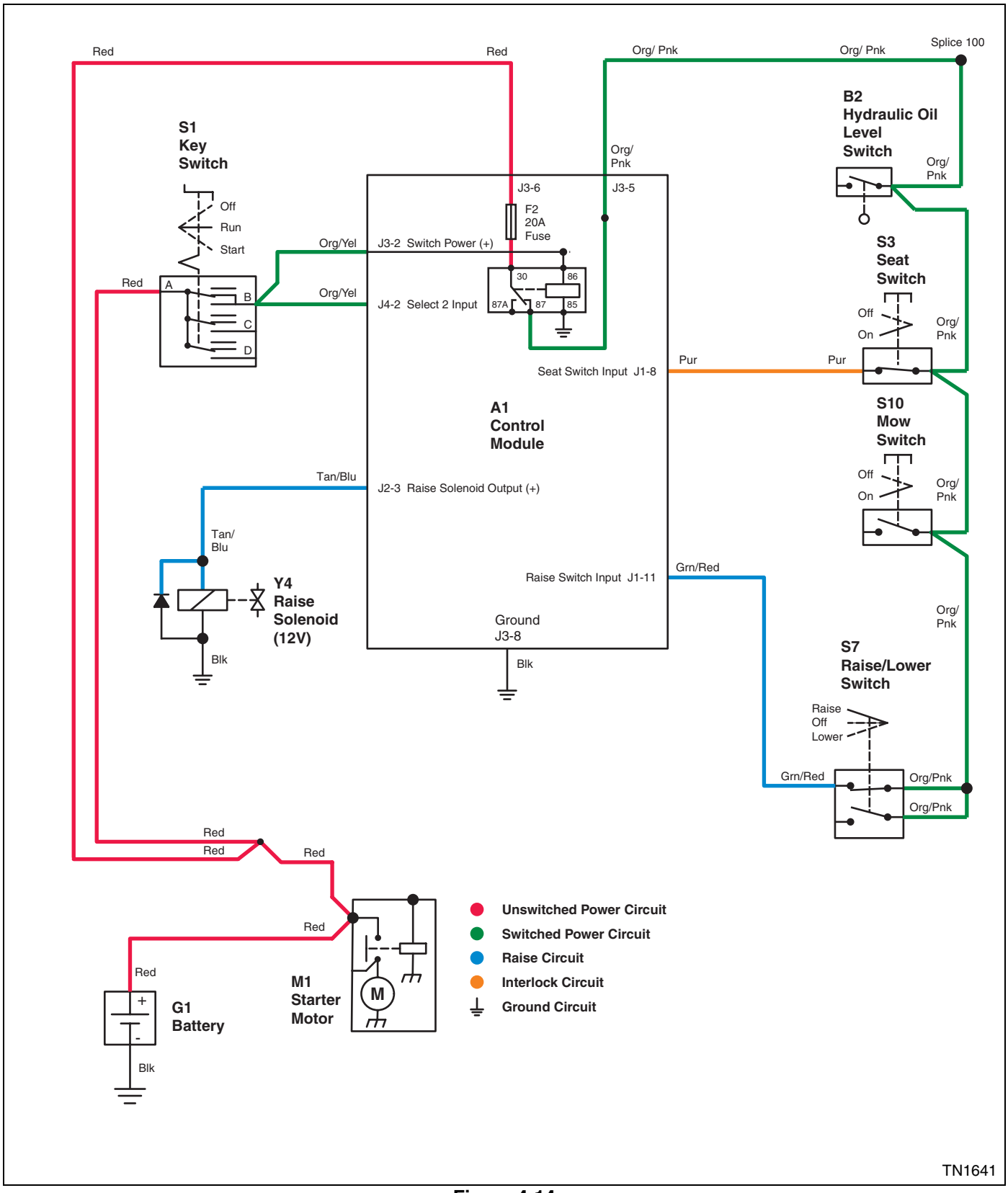

Figure 4-14

Lower Circuit Schematic

See Figure 4-15.

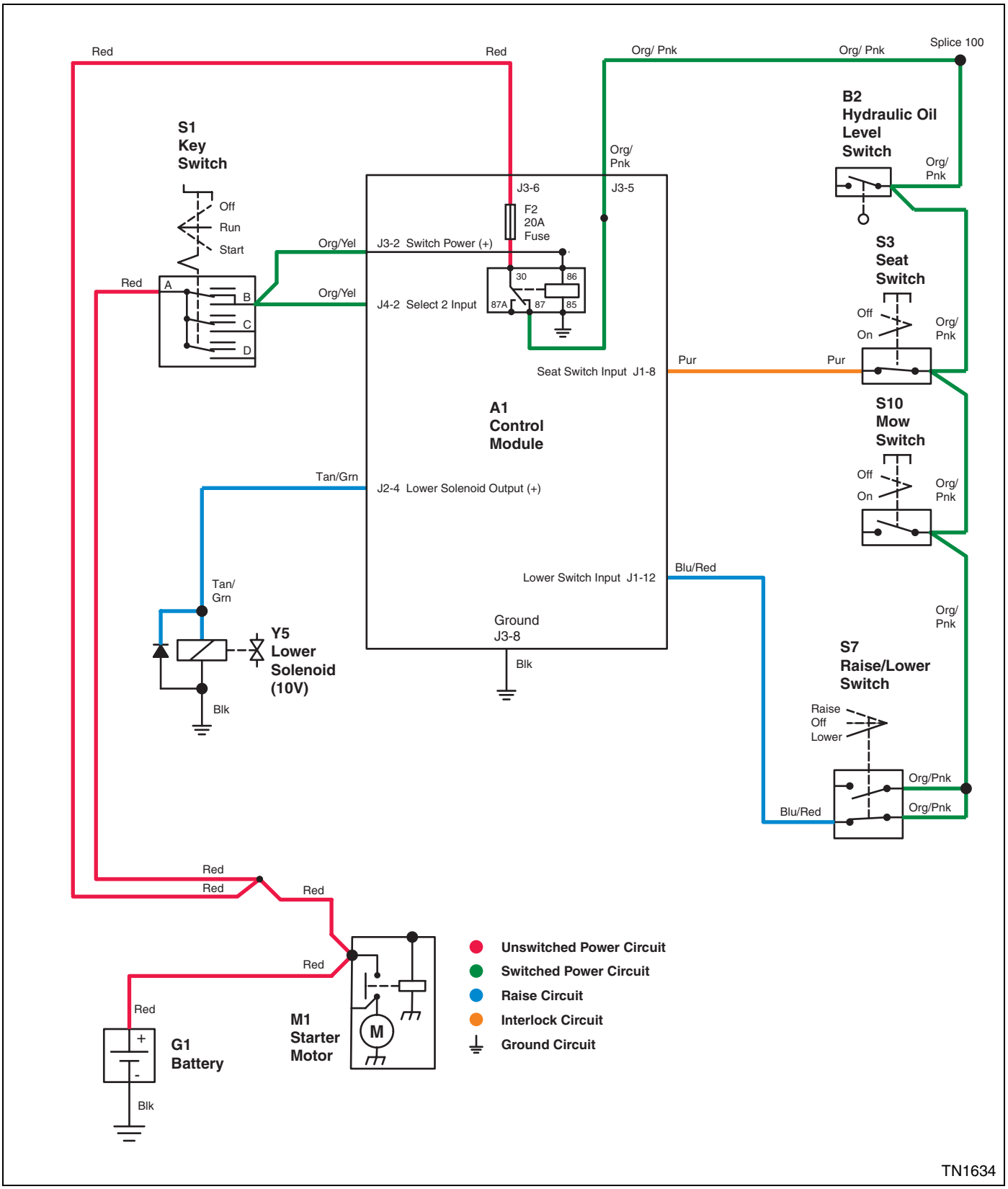

Figure 4-15

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Mow Circuit—Theory of Operation

Power Circuit

Unswitched power is available from the battery positive terminal to the starting motor battery terminal and then from the starting motor battery terminal to 50 amp thermal circuit breaker battery terminal. Unswitched power is available from 50 amp thermal circuit breaker battery terminal to key switch terminal A and control module terminal J3-6.

When the key switch is turned to the run position, voltage is provided from key switch terminal B to control module switch power input terminal J3-2, powering up the control module and energizing the internal switched power relay.

Voltage is also provided from key switch terminal B to control module select 2 input terminal J4-2, activating the input. With the select 2 input activated, the control module selects the software program for this machine. This allows the control module to be used in more than one machine.

With the internal switched power relay energized, switched power is available from switched power relay terminal 87 to control module terminal J3-5. Switched power is available from control module terminal J3-5 to splice 100. From splice 100, switched power is available to the Hydraulic oil level switch.

Switched power is available from hydraulic oil level switch to the seat switch and then from the seat switch to the mow switch.

Interlock Circuit

Before the control module allows activation of the mow circuit, the following must occur:

- Park brake must be in the released position.
- Control module seat switch input activated.

To activate the control module seat switch input, the operator must be on the seat. With the operator is on the seat, the seat switch contacts close. With the seat switch contacts closed, voltage is provided from the switch to control module seat switch input terminal J1-8, activating the input.

Mow Circuit

When the mow switch is in the mow position, voltage is provided to the control module mow switch input terminal J1-10, activating the input. When the raise/lower switch is momentarily placed in the lower position, voltage is provided to control module lower input terminal J1-12, activating the input. (See “Raise/Lower Circuit—Theory of Operation” on page 4-30.)

With the mow switch input activated and lower switch input momentarily activated, current flows from mow solenoid output terminal J3-11 to the mow solenoid, energizing the solenoid.

Mow Circuit Schematic

See Figure 4-16.

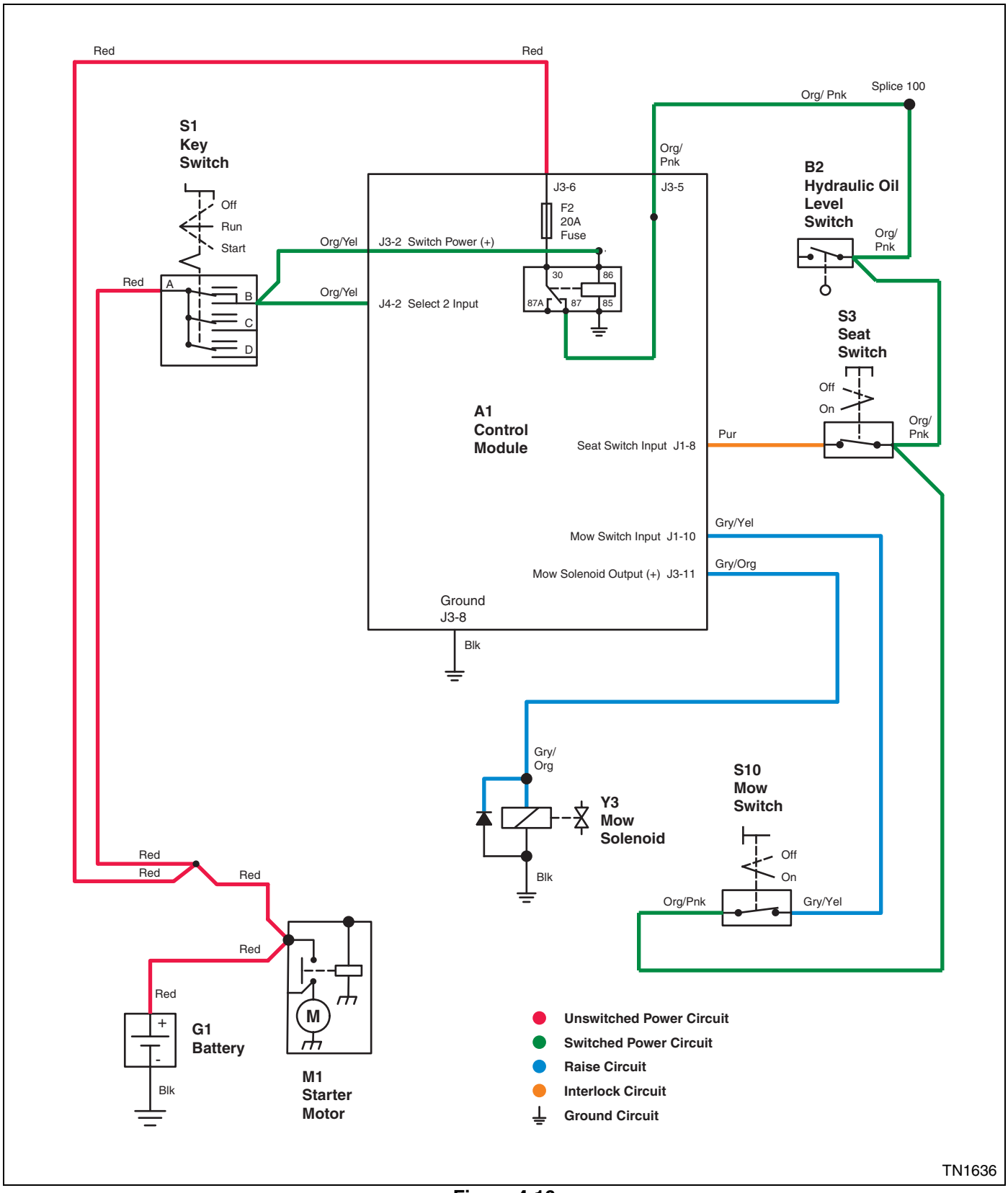

Figure 4-16

Traction Control Circuit—Theory of Operation

Power Circuit

Unswitched power is available from the starting motor battery terminal to 50 amp thermal circuit breaker battery terminal. Unswitched power is available from 50 amp thermal circuit breaker battery terminal to key switch terminal A and control module terminal J3-6.

When the key switch is turned to the run position, voltage is provided from key switch terminal B to control module switch power input terminal J3-2, powering up the control module and energizing the internal switched power relay.

Voltage is also provided from key switch terminal B to control module select 2 input terminal J4-2, activating the input. With the select 2 input activated, the control module selects the software program for this machine. This allows the control module to be used in more than one machine.

With the internal switched power relay energized, switched power is available from switched power relay terminal 87 to control module terminal J3-5. Switched power is available from control module terminal J3-5 to splice 100. From splice 100, switched power is available to the Hydraulic oil level switch. Switched power is available from hydraulic oil level switch to the seat switch.

With the internal switched power relay energized, switched power is available from switched power relay terminal 87 to control module terminal J3-3. Switched power is available from control module terminal J3-3 to splice 90. From splice 90, switched power is available to the traction control switch.

Traction Control Circuit

When the traction control switch is momentarily placed in the on position, voltage is momentarily provided to the control module traction control switch input terminal J1-9, momentarily activating the input. With the input momentarily activated, control module raise solenoid output terminal J2-3 provides voltage to the raise solenoid, energizing the solenoid. At the same time control module lower solenoid output terminal J2-4 provides a pulsing voltage to the lower solenoid.

With a pulsing voltage applied to the lower solenoid and raise solenoid energized, the cutting units are slightly raised, shifting the weight of the mower decks back to the tires.

Control module traction control light output terminal J2-10 also provides voltage to the traction control switch light, turning on the light.

Note: The height the cutting units are raise to can be calibrated. Calibration is required after hydraulic components are replaced or when the control module is replaced.

Traction Control Circuit Schematic

See Figure 4-17.

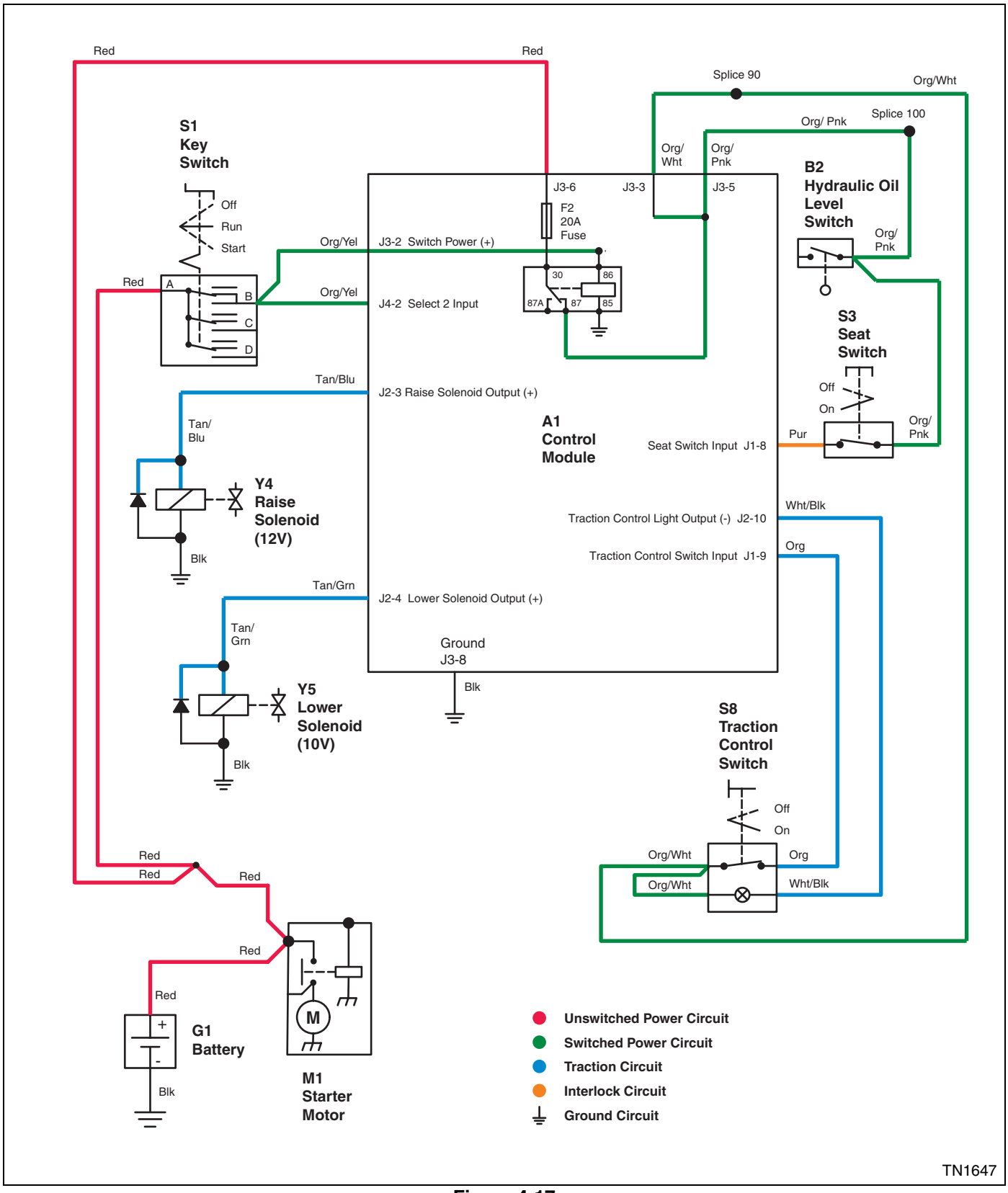

Figure 4-17

Instrumentation Circuit—Theory of Operation

Power Circuit

Unswitched power is available from the starting motor battery terminal to 50 amp thermal circuit breaker battery terminal. Unswitched power is available from 50 amp thermal circuit breaker battery terminal to key switch terminal A and control module terminal J3-6.

When the key switch is turned to the run position, voltage is provided from key switch terminal B to control module switch power input terminal J3-2, powering up the control module. Voltage is also provided from key switch terminal B to control module select 2 input terminal J4-2, activating the input. With the select 2 input activated, the control module selects the software program for this machine. This allows the control module to be used in more than one machine.

With the internal switched power relay energized, switched power is available from switched power relay terminal 87 to control module terminal J3-5. Switched power is available from control module terminal J3-5 to splice 100. From splice 100, switched power is available to the Hydraulic oil level switch.

With the internal switched power relay energized, switched power is available from switched power relay terminal 87 to control module terminal J3-3. Switched power is available from control module terminal J3-3 to splice 90. From splice 90, switched power is available to the traction control switch and then from the traction control switch to the hydraulic oil level light.

Switched power is available from splice 90 to engine temperature gauge and then from the engine temperature gauge to the fuel gauge.

Hour Meter

The fuel gauge provides switched power to the hour meter, and the hour meter starts logging hours.

Engine Oil Pressure Light

When the engine oil pressure is below 7 psi (0.483 bar), the engine oil pressure switch contacts close. With the switch contacts closed, a ground is provided to the engine oil pressure light, turning on the light.

With the engine oil pressure switch closed, a ground is also provided from the switch to control module engine oil pressure input terminal J2-1, activating the input. With the input activated and after a 30 second delay the control module does not allow the mow circuit to operate. At the same time the control module horn output terminal J3-10 provides voltage to the horn, turning on the horn. The horn sounds for 5 seconds and then chirps every 3 seconds.

Hydraulic Filter Pressure Light

The hydraulic filter switch is a differential pressure switch. The switch closes when there is a 25 psi (1.724) drop between the inlet and outlet pressures of the filter.

When the hydraulic filter pressure switch closes, a ground is also provided from the switch to control module hydraulic filter pressure input terminal J2-2, activating the input. With the input activated and after a 5 second delay, control module hydraulic filter pressure light output terminal J2-8 provides a ground to the hydraulic filter pressure light, turning on the light. At the same time the control module horn output terminal J3-10 provides voltage to the horn, turning on the horn. The horn sounds for 5 seconds and then chirps every 3 seconds. The control module does not allow the mow circuit to operate when the hydraulic filter pressure switch input is activated.

Fuel Gauge

The float attached to the fuel level sender moves as the fuel level changes to various levels. The resistance of the fuel level sender changes in relationship to the position of the float. As the resistance changes, the amount of current flowing through the circuit changes and the amount of current flowing is indicated by the fuel gauge.

Engine Temperature Gauge

The engine temperature sensor resistance changes in relationship to the engine coolant temperature. As the engine temperature sensor is heated, the resistance of the sensor changes from a high resistance to a low resistance. The amount of resistance in the circuit controls the amount of current flowing through the engine temperature gauge. The amount of current flowing through the circuit is indicated by the gauge as a temperature measurement.

The voltage drop across the temperature sensor is provided to control module engine temperature sensor input terminal J2-12. The amount of voltage across the sensor also has a relationship to temperature.

When the engine coolant temperature reaches 230°F (110°C), the voltage across the sensor signals the control module to not allow the mow circuit to operate and sound the horn. The horn sounds for 5 seconds and then chirps every 3 seconds. There is a 30 second delay before the control module activates the horn circuit.

Hydraulic Oil Level Light

When the hydraulic level switch closes, voltage is provided to control module hydraulic oil level switch input terminal J1-1, activating the input. With the input activated and after a 5 second delay, the control module hydraulic oil level light output terminal J2-9 provides a ground to the hydraulic oil level light, turning on the light. At the same time the control module does not allow the mow circuit to operate and sounds the horn for 5 seconds and then chirps every 3 seconds.

Instrumentation Circuit Schematic

See Figures 4-18 through 4-19.

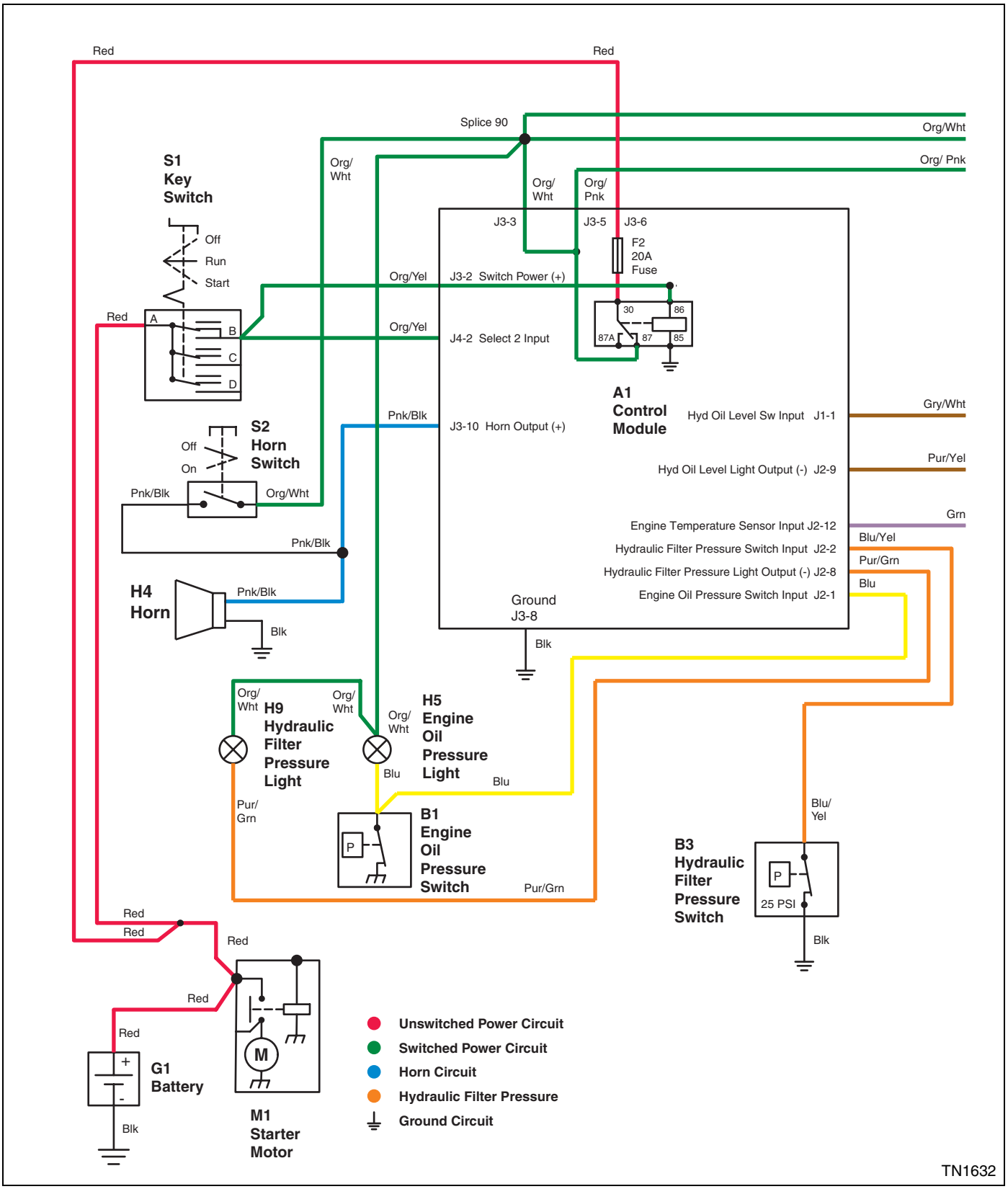

Figure 4-18

Instrumentation Circuit Schematic Continued

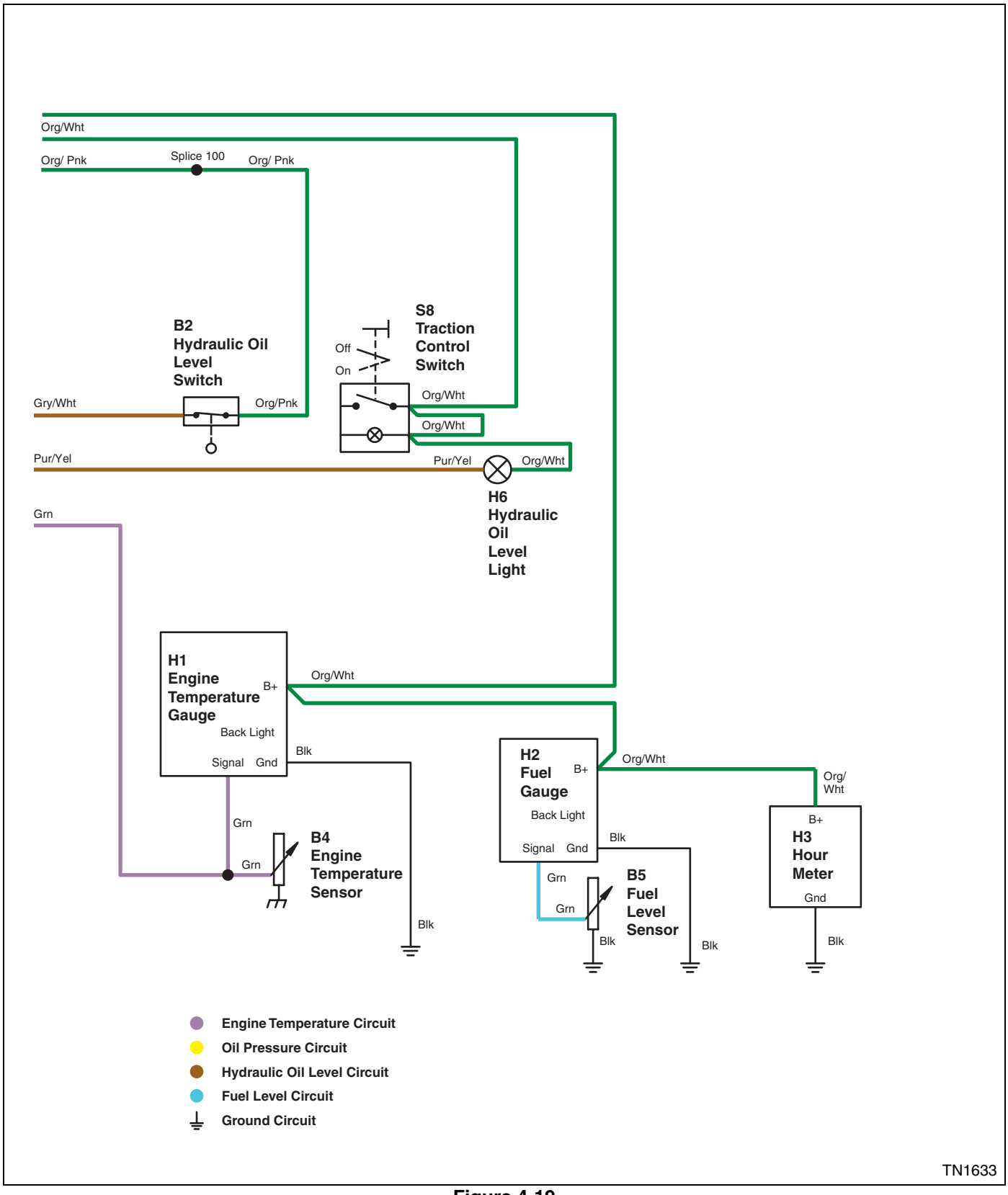

Figure 4-19

Horn and Light Circuit—Theory of Operation

Power Circuit

Unswitched power is available from the battery positive terminal to the starting motor battery terminal and then from the starting motor battery terminal to 50 amp thermal circuit breaker battery terminal.

Unswitched power is available from 50 amp thermal circuit breaker battery terminal to key switch terminal A and control module terminals J3-6 and J3-7.When the key switch is turned to the run position, voltage is provided from key switch terminal B to control module switch power input terminal J3-2, powering up the control module and energizing the two internal switched power relays.

Voltage is also provided from key switch terminal B to control module select 2 input terminal J4-2, activating the input. With the select 2 input activated, the control module selects the software program for this machine. This allows the control module to be used in more than one machine.

With the internal switched power relays energized, switched power is available from switched power relay terminal 87 to control module terminal J3-3. Switched power is available from control module terminal J3-3 to splice 90. From splice 90, switched power is available to the horn switch.

With the internal switched power relays energized, switched power is also available from switched power relay terminal 87 to control module terminal J3-4. Switched power is available from control module terminal J3-4 to the light switch.

Horn Circuit

When the horn switch is placed in the on position, voltage is provided to the horn, turning on the horn.

Light Circuit

When the light switch is in the on position, voltage is provided to splice 390. Splice 390 provides voltage to right and left work lights, turning on the lights.

Splice 390 provides voltage to engine temperature gauge backlight terminal, lighting the gauge.

Splice 390 also provides voltage to fuel gauge backlight terminal, lighting the gauge.

Horn and Light Circuit Schematic

See Figure 4-20.

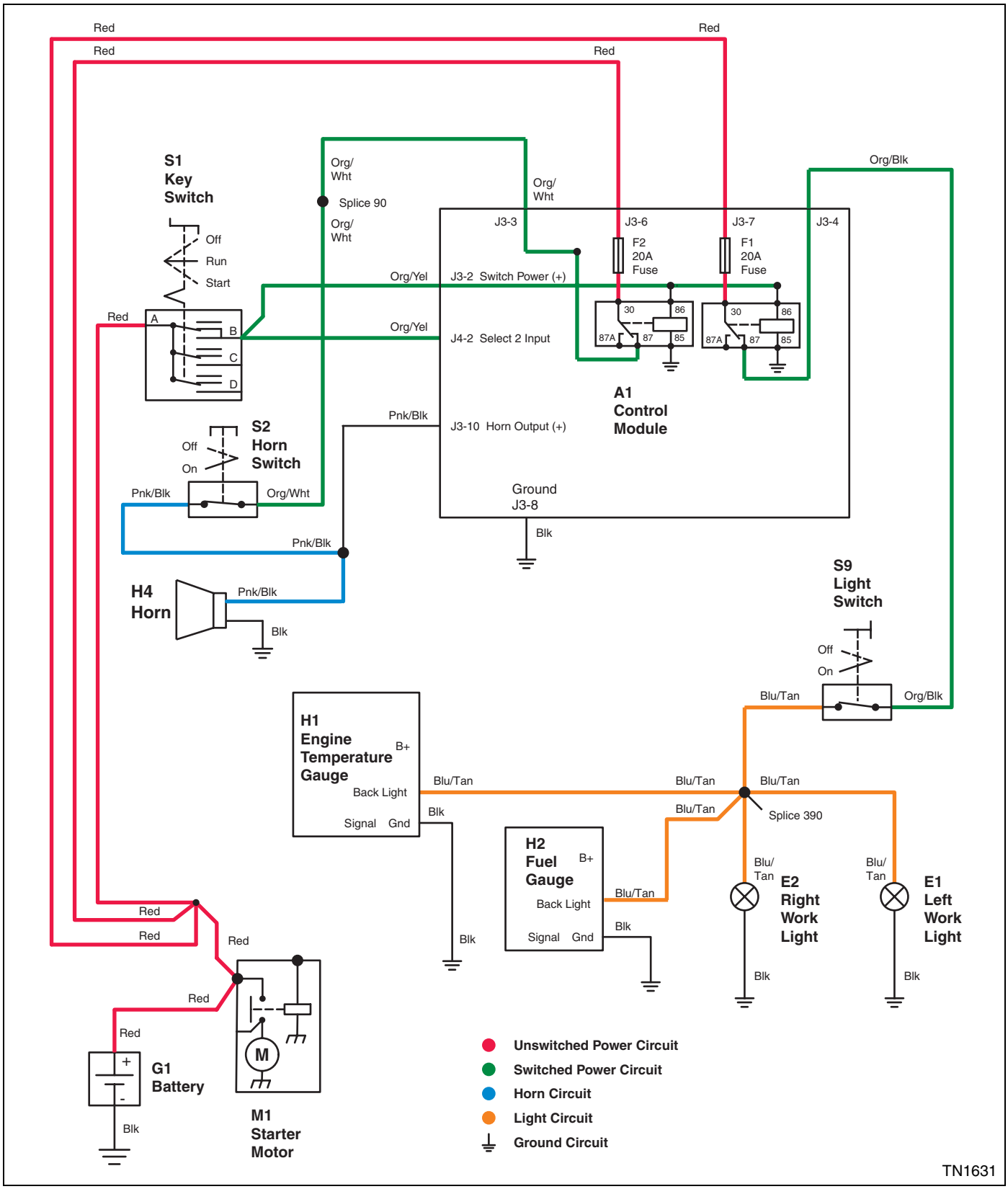

Figure 4-20

Optional Cruise Control—Theory of Operation

Power Circuit

Unswitched power is available from the starting motor battery terminal to 50 amp thermal circuit breaker battery terminal. Unswitched power is available from 50 amp thermal circuit breaker battery terminal to key switch terminal A and control module terminal J3-6.

When the key switch is turned to the run position, voltage is provided from key switch terminal B to control module switch power input terminal J3-2, powering up the control module. Voltage is also provided from key switch terminal B to control module select 2 input terminal J4-2, activating the input. With the select 2 input activated, the control module selects the software program for this machine. This allows the control module to be used in more than one machine.

With the internal switched power relay energized, switched power is available from switched power relay terminal 87 to control module terminal J3-5. Switched power is available from control module terminal J3-5 to splice 100. From splice 100, switched power is available to the park brake proximity switch.

With the internal switched power relay energized, switched power is available from switched power relay terminal 87 to control module terminal J3-3. Switched power is available from control module terminal J3-3 to splice 90. From splice 90, switched power is available to the cruise control switch.

Cruise Control Circuit

When the cruise control switch is placed in the on position, voltage is provided to the cruise control module, powering up the module. With the module powered up, current flows to the cruise control magnet, energizing the magnet. With the magnet energized, the traction pedal linkage is held in the current position.

When the park brake pedal is de-pressed, voltage is provided from the switch to cruise control module cancel input terminal J8-1, activating the input. With the input activated, the cruise control module de-energizes the cruise control magnet, releasing the traction pedal linkage. To re-enable the cruise control circuit, the cruise control switch must be placed in the off and then in the on position.

Cruise Control Circuit Schematic

See Figure 4-21.

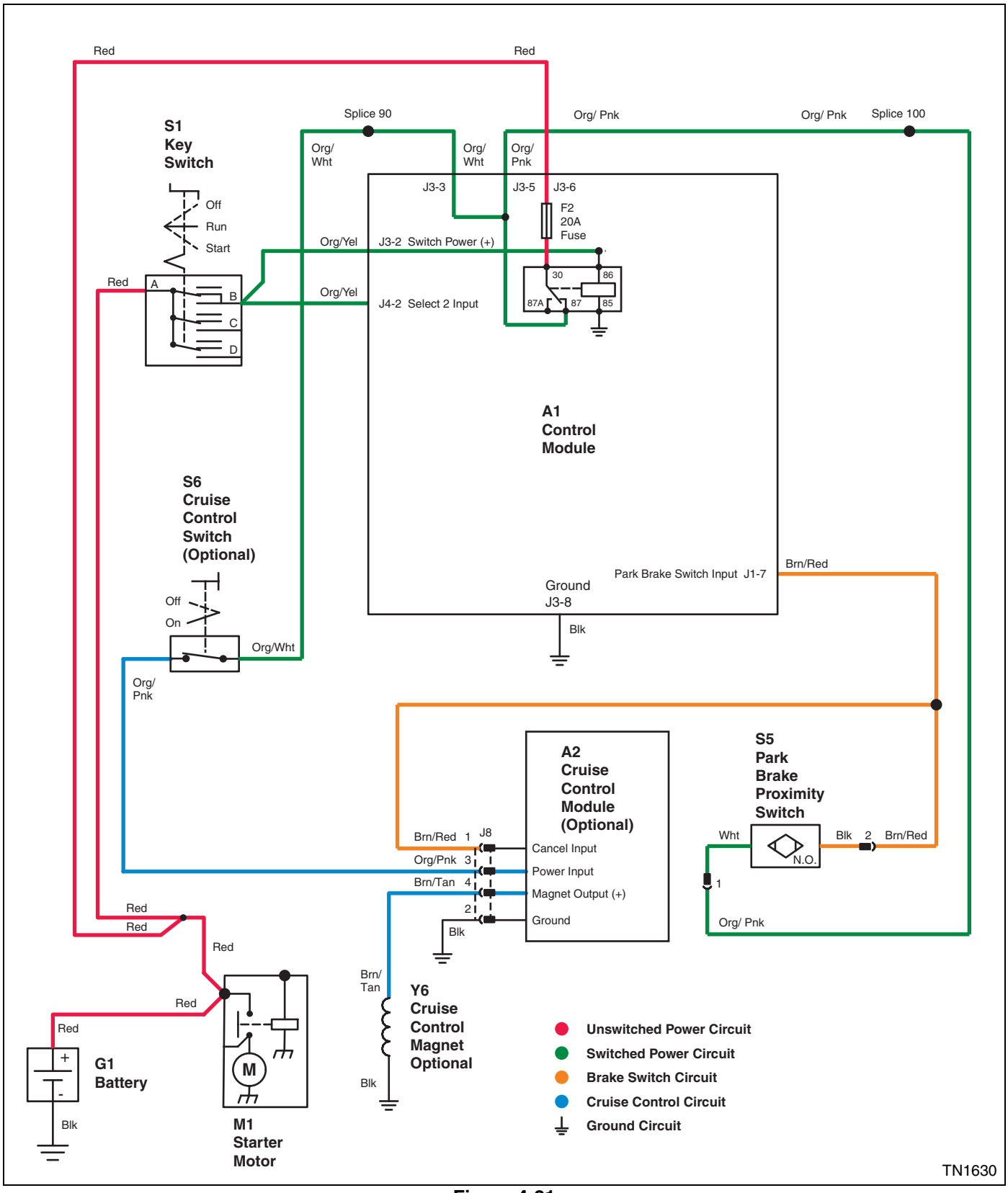

Figure 4-21

Troubleshooting

Control Module

Symptom: Control module does not power up.

Probable Cause	Remedy
Open fuse 20A fuse F2.	Test fuse. (See “Fuse Test” on page 4-57.)
Faulty control module unswitched power circuit.	Measure voltage between control module terminal J3-5 and ground. Voltage must be approximately 12 VDC.
Faulty control module switched power circuit.	With the key switch in the run position, measure voltage between control module terminal J3-2 and ground. Voltage must be approximately 12 VDC.
Open control module ground circuit.	Check continuity between control module terminal J3-8 and ground. Continuity must be indicated.
Faulty key switch	Test key switch.
Faulty control module.	Substitute the control module with a known good control module.

Park Brake Circuit

Symptom: Control module brake sw LED does not turn on.

Probable Cause	Remedy
Faulty wiring harness or park brake proximity switch.	Disconnect park brake proximity switch connector from wiring harness. With a jumper wire, connect the park brake switch connector Org/Pnk and Brn/Red wire terminals together. With the key switch in the run position, check the control module brake sw LED. If the LED turns on, substitute the park brake proximity switch with a known good switch. If the LED does not turn on, measure voltage between park brake proximity switch Org/Pnk wire terminal and ground. Voltage must be approximately 12 VDC. If the LED does not turn on, check continuity between park brake proximity switch Brn/Red wire terminal and control module terminal J1-7. Continuity must be indicated.

Neutral Circuit

Symptom: Control module brake sw LED does not turn on.

Probable Cause	Remedy
Faulty wiring harness or neutral proximity switch.	Disconnect neutral proximity switch connector from wiring harness. With a jumper wire, connect the neutral switch connector Org/Pnk and Brn/Wht wire terminals together. With the key switch in the run position, check the control module brake sw LED. If the LED turns on, substitute the neutral proximity switch with a known good switch. If the LED does not turn on, measure voltage between neutral proximity switch Org/Pnk wire terminal and ground. Voltage must be approximately 12 VDC. If the LED does not turn on, check continuity between neutral proximity switch Brn/Wht wire terminal and control module terminal J1-7. Continuity must be indicated.

Charging Circuit

Symptom: Battery not charging.

Probable Cause	Remedy
Faulty alternator output circuit.	Make sure alternator output cable and battery positive (+) cable terminals are clean and tight. Check continuity between starter battery terminal and battery positive (+) terminal. Continuity must be indicated.
Faulty battery ground circuit.	Make sure battery negative (–) cable terminals are clean and tight. Check continuity between battery negative (–) terminal and ground. Continuity must be indicated.
Faulty battery.	Check specific gravity of the individual battery cells.

Symptom: Alternator light stays on.

Probable Cause	Remedy
Missing excitation voltage.	With the key switch in the run position, measure voltage between alternator ignition terminal (Org/Wht wire). Voltage must be approximately 12 VDC.
Faulty alternator.	With the engine running, measure voltage between jump start connector terminals. Voltage must be approximately 14 VDC. If the voltage is below 12 volts, replace the alternator.

Glow Plug Circuit

Symptom: Glow plugs do not get hot.

Probable Cause	Remedy
Faulty control module output circuit.	Cycle key switch between the run and start positions and check control module glow plug relay output LED. If the LED does not come on, substitute the control module with a known good control module.
Faulty power circuit.	Check continuity between 50A thermal circuit breaker F3 and glow plug relay terminal 30. Continuity must be indicated.
Faulty glow plug relay.	Test relay. (See “Relay Tests” on page 4-57.)
Open glow plug relay ground circuit.	Check continuity between glow plug relay terminal 85 and ground. Continuity must be indicated.
Faulty glow plug relay output circuit.	Measure voltage between glow plug terminal strip and ground. Voltage must be approximately 12 VDC.
Faulty connection at glow plug terminal strip.	Clean and tighten ring terminal connector.

Start Circuit

Symptom: Starter motor solenoid does not engage.

Probable Cause	Remedy
Park brake pedal is in the released position.	Place the park brake pedal in the locked position.
Traction pedal not in the neutral position.	Move the traction pedal to the neutral position.
Mow switch is in the mow position.	Place the mow switch in the off position.
Faulty park brake proximity switch.	Test switch. (See “Park Brake Circuit” on page 4-46.)
Faulty neutral proximity switch.	Test switch. (See “Neutral Circuit” on page 4-46.)
Faulty key switch.	With the key switch in the start position, check control module start sw input LED. If the LED does not light, test switch. (See “Key Switch Test” on page 4-58.)
Faulty control module output.	With the key switch in the start position, check control module starter relay output LED. If the LED does not come on, substitute the control module with a known good control module. Note: The glow plug circuit must time out before the starter relay output becomes active.
Faulty Start relay.	Test relay. (See “Relay Tests” on page 4-57.)
Faulty power circuit.	Measure voltage between start relay terminal 30 and ground. Voltage must be approximately 12 VDC.
Faulty start relay ground circuit.	Measure continuity between start relay terminal 85 and ground. Continuity must be indicated.

Run Circuit

Symptom: Engine stops running when the park brake is released.

Probable Cause	Remedy
Faulty seat switch.	With the seat cushion depressed, check control module seat sw input LED. If the LED does not light test the seat switch.
Faulty switched power circuit.	Measure voltage between seat switch Org/Pnk wire terminal and ground. Voltage must be approximately 12 VDC.
Faulty 12V fuel solenoid output circuit.	With the key switch in the start position, measure voltage between the control module fuel solenoid output terminal and ground. Voltage must be approximately 12 VDC.
Faulty control module.	Substitute the control module with a known good control module.

Raise/Lower Circuit

Symptom: Lower solenoid does not energize.

Probable Cause	Remedy
Faulty raise/lower switch.	With the raise/lower switch in the lower position, check control module joystick lower sw LED. If the LED does not light, test the switch. (See “Raise/Lower Switch Test” on page 4-59.)
Faulty switched power circuit.	Measure voltage between raise/lower switch org/pnk terminals and ground. Voltage must be approximately 12 VDC.
Faulty lower switch input circuit.	With the raise/lower switch in the lower position, measure voltage between control module joystick lower sw input terminal and ground. Voltage must be approximately 12 VDC.
Faulty control module output circuit	With the raise/lower switch in the lower position, check control module lower sol output LED. If the LED does not light, substitute the control module with a known good control module.
Faulty lower solenoid output circuit.	Momentarily place the raise/lower switch in the lower position. Measure voltage between control module lower solenoid output terminal and ground. Measure voltage between lower solenoid tan/grn wire terminal and ground. Voltage must be approximately 12 VDC.
Open lower solenoid ground circuit.	Check continuity between lower solenoid blk wire terminal and ground. Continuity must be indicated.
Faulty lower solenoid.	Test solenoid. (See “Solenoid Test” on page 4-63.)

Symptom: Raise solenoid does not energize.

Probable Cause	Remedy
Faulty raise/lower switch.	With the raise/lower switch in the lower position, check control module joystick raise sw LED. If the LED does not light, test the switch. (See “Raise/Lower Switch Test” on page 4-59.)
Faulty switched power circuit.	Measure voltage between raise/lower switch org/pnk terminals and ground. Voltage must be approximately 12 VDC.
Faulty raise switch input circuit.	With the raise/lower switch in the raise position, measure voltage between control module joystick raise sw input terminal and ground. Voltage must be approximately 12 VDC.
Faulty control module output circuit	With the raise/lower switch in the raise position, check control module lift sol output LED. If the LED does not light, substitute the control module with a known good control module.
Faulty raise solenoid output circuit.	Momentarily place the raise/lower switch in the raise position. Measure voltage between control module raise solenoid output terminal and ground. Measure voltage between raise solenoid tan/blu wire terminal and ground. Voltage must be approximately 12 VDC.
Open raise solenoid ground circuit.	Check continuity between lower solenoid blk wire terminal and ground. Continuity must be indicated.
Faulty raise solenoid.	Test solenoid. (See “Solenoid Test” on page 4-63.)

Mow Circuit

Symptom: Mow solenoid does not energize.

Probable Cause	Remedy
Raise/lower switch was not momentarily placed in the lower position.	Momentarily place the raise/lower switch in the lower position to activate the cutting units.
Faulty mow switch.	With the mow switch in the on position, check control module mow sw input LED. If the LED does not light, test switch. (See “Mow Switch” on page 4-62.)
Faulty switched power circuit.	Measure voltage between mow switch org/pnk terminal and ground. Voltage must be approximately 12 VDC.
Faulty control module input circuit.	With the mow switch in the mow position, measure voltage between control module mow switch input terminal and ground. Voltage must be approximately 12 VDC.
Faulty control module output circuit	With the raise/lower switch in the raise position, check control module lift sol output LED. If the LED does not light, substitute the control module with a known good control module.
Faulty mow solenoid output circuit.	With the mow switch in the on position and the raise/lower switch in the lower position, measure voltage between control module mow solenoid output terminal and ground. Measure voltage between mow solenoid gry/org wire terminal and ground. Voltage must be approximately 12 VDC.
Open mow solenoid ground circuit.	Check continuity between mow solenoid blk wire terminal and ground. Continuity must be indicated.
Faulty mow solenoid.	Test solenoid. (See “Solenoid Test” on page 4-63.)

Traction Control Circuit

Symptom: Traction control circuit will not operate.

Probable Cause	Remedy
Faulty traction control switch.	With the traction control switch in the on position, check control module lvl/deck lift sw input LED. If the LED does not come on, test the switch. (See “Traction Control Switch Test” on page 4-60.)
Faulty switched power circuit.	With the key switch in the run position, measure voltage between the traction control switch org/wht wire terminals. Voltage must be approximately 12 VDC.
Faulty control module input circuit.	Check continuity between control module traction control input terminal J1-9 and traction control switch org wire terminal. Continuity must be indicated.
Faulty traction control switch light.	Test switch. (See “Traction Control Switch Test” on page 4-60.)
Faulty control module output circuit.	Momentarily place the traction control switch in the on position, check control module 6-7 enable/tc on output LED. If the LED does not light, substitute the control module with a known good control module.
Faulty traction control output circuit.	Check continuity between control module traction control light output terminal J2-10 and traction control switch wht/blk wire terminal. Continuity must be indicated.

Instrumentation Circuit

Lamp and Audible Alarm Check Circuit

The control module provides a lamp and audible alarm check circuit. When the key switch is turned to the run position the control module turns on the following for approximately 3 seconds:

- Glow plug light
- Hydraulic filter pressure light
- Hydraulic oil level light
- Horn (chirping)

After the lamp and audible alarm check circuit times out, the alternator and oil pressure light remains on because the engine is not operating. If any of the lights fail to turn on check the light bulbs.

Symptom: Engine oil pressure light does not turn on.

Probable Cause	Remedy
Faulty engine oil pressure switch.	With the key switch in the off position, check continuity between engine oil pressure switch and ground. Continuity must be indicated. If continuity is not indicated, replace engine oil pressure switch.
Faulty engine oil pressure light switched power circuit.	With the key switch in the run position (engine off), measure voltage between engine oil pressure light org/wht wire terminal and ground. Voltage must be approximately 12 VDC.
Faulty engine oil pressure switch circuit.	Check continuity between engine oil pressure switch terminal and engine oil pressure light terminal (blue wire). Continuity must be indicated.
Faulty LED.	Substitute the LED with a known good LED.

Symptom: Engine oil pressure light stays on with engine running.

Probable Cause	Remedy
Low engine oil pressure.	Check engine oil pressure.
Faulty engine oil pressure switch.	If engine oil pressure tests good, replace engine oil pressure switch.

Symptom: Glow plug wait light does not come on.

Probable Cause	Remedy
Faulty control module output circuit.	With key switch in the run position, check control module glow plug lamp output LED. If the LED turns on for approximately 3 seconds, check continuity between control module glow plug lamp output terminal J2-11. Continuity must be indicated. If the LED does not turn on, substitute the control module with a known good control module.
Faulty switched power circuit.	Measure voltage between glow plug lamp Org/Wht terminal and ground. Voltage must be approximately 12 VDC.

Symptom: Hydraulic filter pressure light does not turn on with a blocked filter.

Probable Cause	Remedy
Faulty Control module output circuit.	With the key switch in the run position, check control module hydr fltr lamp output LED. If the LED turns on for approximately 3 seconds, check continuity between hydraulic filter pressure light pur/grn wire terminal and control module hydraulic filter pressure light output terminal J2-8. If the LED does not turn on, substitute the control module with a known good control module.
Faulty hydraulic filter pressure light switched power circuit.	With the key switch in the run position (engine off), measure voltage between hydraulic filter pressure light org/wht terminal and ground. Voltage must be approximately 12 VDC.
Faulty control module input circuit.	Connect a jumper wire hydraulic filter pressure switch blu/yel wire terminal and ground. With the key switch in the run position, check control module hydr fltr sw input LED. If the LED does not turn on, check continuity between hydraulic filter pressure switch bul/yel wire terminal and control module hydraulic filter pressure switch input terminal J2-2. Continuity must be indicated. If the wiring checks good, substitute the control module with a known good control module.
Faulty hydraulic filter pressure switch.	Replace hydraulic filter switch.

Symptom: Hydraulic filter pressure light is on with the key switch in the run position (engine off).

Probable Cause	Remedy
Faulty hydraulic filter pressure switch.	Replace hydraulic filter switch.

Symptom: Hydraulic filter pressure light is on with the key switch in the run position (engine on).

Probable Cause	Remedy
Blocked hydraulic filter.	Replace hydraulic filter.
Faulty hydraulic filter pressure switch.	Replace hydraulic filter pressure switch.

Symptom: Engine temperature gauge indicates a temperature when the engine is cold.

Probable Cause	Remedy
Faulty engine temperature sensor.	Replace engine temperature sensor.
Faulty ground circuit.	Check continuity between the engine temperature gauge and ground. Continuity must be indicated.

Symptom: Engine temperature gauge does not indicate a temperature.

Probable Cause	Remedy
Faulty engine temperature sensor.	With a jumper wire, connect the engine temperature sensor to ground. With the key switch in the run position, check the gauge. If the gauge is indicating full scale, replace the engine temperature sensor.
Faulty engine temperature circuit.	Check continuity between engine temperature gauge grn wire terminal and the engine temperature sensor terminal. Continuity must be indicated.
Faulty switched power circuit.	With the key switch in the on position, measure voltage between engine temperature gauge org/wht terminal and ground. Voltage must be approximately 12 VDC.
Faulty ground circuit.	Check continuity between engine temperature gauge blk wire terminal and ground. Continuity must be indicated.
Faulty engine temperature gauge.	Replace the engine temperature gauge.

Horn and Audible Alert Circuit

Symptom: Horn does not sound when horn switch is pressed.

Probable Cause	Remedy
Faulty horn switch.	With the key switch in the run position, pressed the horn switch. If the horn does not sound, test horn switch.
Faulty horn.	Connect a test light between horn terminals (pnk/blk and blk wires). With the key switch in the run position, pressed the horn switch. If the test light turns on and the horn does not sound, replace the horn.
Faulty switched power circuit.	Measure voltage between horn switch org/wht terminal and ground. Voltage must be approximately 12 VDC.
Faulty horn switch circuit.	Check continuity between horn switch pnk/blk wire terminal and horn pnk/blk wire terminal. Continuity must be indicated.
Faulty ground circuit.	Check continuity between horn blk wire terminal and ground. Continuity must be indicated.

Symptom: Horn does not sound during lamp and audible alarm check.

Probable Cause	Remedy
Faulty horn.	With the key switch in the run position, pressed the horn switch. If the horn does not sound, see “Symptom: horn does not sound”.
Faulty horn output circuit.	With the key switch in the run position, check control module audible alarm output LED. If the LED flashes at 0.5 second rate for approximately 3 seconds and the horn does not sound, check continuity between horn pnk/blk wire terminal and control module horn output terminal J3-10. Continuity must be indicated If the LED does not turn on, substitute the control module with a known good control module.

Symptom: Horn does not sound with engine oil pressure light on.

Probable Cause	Remedy
Faulty engine oil pressure switch input circuit.	With the key switch in the run position and engine off, check control module engine oil pressure switch input LED. If the LED does not come on, check continuity between engine oil pressure switch terminal and control module engine oil pressure switch input terminal J2-1. Continuity must be indicated.

Symptom: Horn does not sound with engine temperature reaches overtemp.

Probable Cause	Remedy
Faulty engine temperature sensor input circuit.	Check continuity between engine temperature sensor grn wire terminal and control module engine temperature sensor input terminal J2-12. Continuity must be indicated.

Light Circuit

Symptom: Work lights do not turn on.

Probable Cause	Remedy
Open fuse 20A fuse F1.	Test fuse. (See “Fuse Test” on page 4-57.)
Faulty light switch.	Test switch. (See “Light Switch Test” on page 4-60.)

Component Testing

Electrical System and Component Testing

General Information

Repair of the electrical system, for the most part, is limited to the replacement of defective components or wiring. When replacing either electrical components or wiring, be sure to apply dielectric grease to all connector terminals to prevent corrosion. Wiring diagrams are provided in this section for troubleshooting and/or testing the electrical system. Specific testing and replacement information, where applicable, is also provided in this section.

In addition to testing a suspected faulty component, it may be necessary to check for shorts or breaks in the wiring to the component. A common method of testing wires or circuits is to perform a continuity check as described in the following tests.

NOTE

Before performing any component or wiring tests, check for corrosion and loose or missing connections.

If a component (switch, relay, etc.) is removed for testing or replacement, make sure to identify and label all wires so that the component can be installed correctly.

Continuity Test

Required Tools or Equipment
Digital Multimeter, Ohmmeter, or Continuity Tester

1. Identify and locate the wire or component to be checked using the electrical schematic.

NOTE

Some meters may have a continuity tester setting that uses a buzzer to indicate continuity. See the meter operator's manual for more information.

2. If using a multimeter, set to read ohms or set meter to continuity setting.
3. Disconnect the ends of the wire being tested.
4. Touch meter leads to the ends of the wire or to the terminals of the component to be tested.

   Does meter read less than 0.5 ohm, and/or does the buzzer sound?

   YES *The wire is good.*

   NO *Proceed to step 5.*

5. Use a known good jumper wire of the correct gauge to bypass the wire in question.
6. Test the function of the circuit.

   Does the circuit now operate properly?

   YES *Replace the wire.*

   NO *Continue testing other wires and components in the circuit.*

Resistance Test

Required Tools or Equipment
Digital Multimeter or Ohmmeter

1. Identify and locate the wire or component to be checked using the electrical schematic.

NOTE

On some meters it will be necessary to select an ohms scale. Select an appropriate range for the component being tested. Refer to the specifications listed in the component test procedure.

2. If using a multimeter, set to read ohms.
3. Isolate (disconnect) the component to be tested from the circuit to prevent a false reading through the circuit.
4. Connect the meter leads to the terminals of the component being tested. Check the component test procedure for specifications and additional test conditions.

   Does the resistance through the component match the specified value listed in the test procedure?

   YES *The component is good.*

   NO *Replace the component.*

Fuse Test

Plug-In Fuses

See Figure 4-22.

Required Tools or Equipment
Digital Multimeter, Ohmmeter, or Continuity Tester

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove fuse from fuse holder. (See “Plug-In Fuses” on page 4-69.)

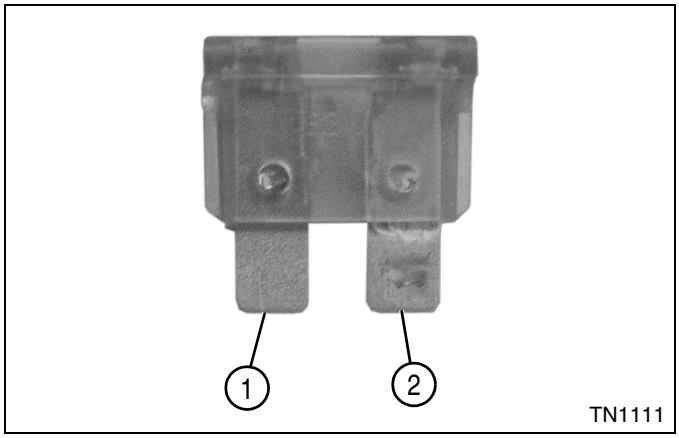

Figure 4-22

3. Connect one test lead to terminal (1).
4. Connect the other test lead to the other terminal (2) and check for continuity.

   Is continuity indicated?

   YES *The fuse is good.*

   NO *The fuse is faulty; replace the fuse.*

Relay Tests

Start Relay

See Figure 4-23.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove the start relay. (See “Start Relay” on page 4-70.)

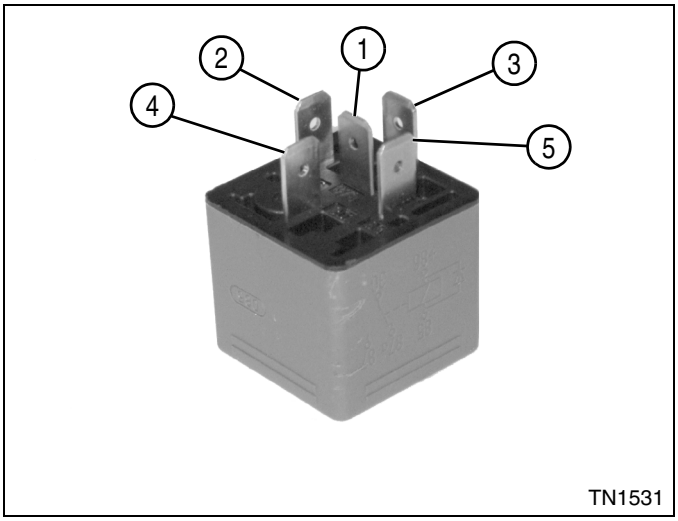

Figure 4-23

3. Connect one test lead to terminal (4).
4. Connect the other test lead to terminal (1) and check for continuity.

   Is continuity indicated?

   YES *Proceed to step 5.*

   NO *The relay is faulty; replace the relay.*
5. Connect one test lead to terminal (4).
6. Connect the other test lead to terminal (3).
7. Connect a 12-volt DC power source to terminals (2 and 5).
8. Check for continuity across terminals (3 and 4).

   Is continuity indicated?

   YES *The relay is good.*

   NO *The relay is faulty; replace the relay.*

Glow Plug Relay

See Figure 4-24.

Required Tools or Equipment
Digital Multimeter, or Ohmmeter, or Continuity Tester 12-Volt DC Power Source and Leads

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove the glow plug relay. (See “Glow Plug Relay” on page 4-70.)

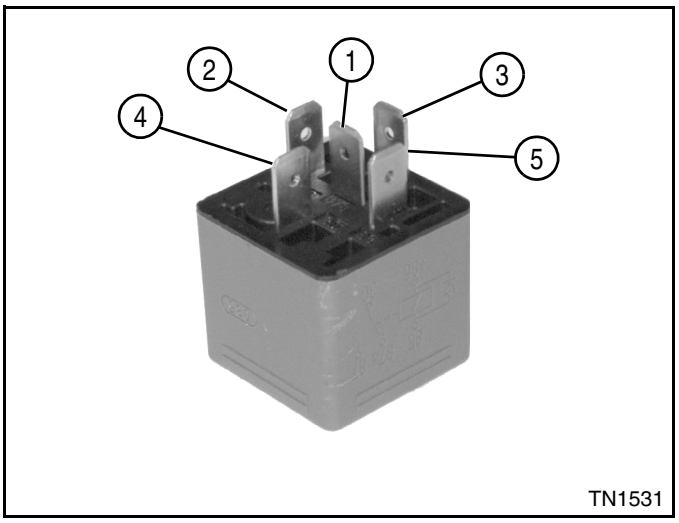

Figure 4-24

3. Connect one test lead to terminal (4).
4. Connect the other test lead to terminal (1) and check for continuity.

   Is continuity indicated?

   YES *Proceed to step 5.*

   NO *The relay is faulty; replace the relay.*
5. Connect one test lead to terminal (4).
6. Connect the other test lead to terminal (3).
7. Connect a 12-volt DC power source to terminals (2 and 5).
8. Check for continuity across terminals (3 and 4).

   Is continuity indicated?

   YES *The relay is good.*

   NO *The relay is faulty; replace the relay.*

Key Switch Test

See Figure 4-25.

Required Tools or Equipment
Digital Multimeter, Ohmmeter, or Continuity Tester

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove the key switch from the instrument panel. (See “Key Switch” on page 4-71.)

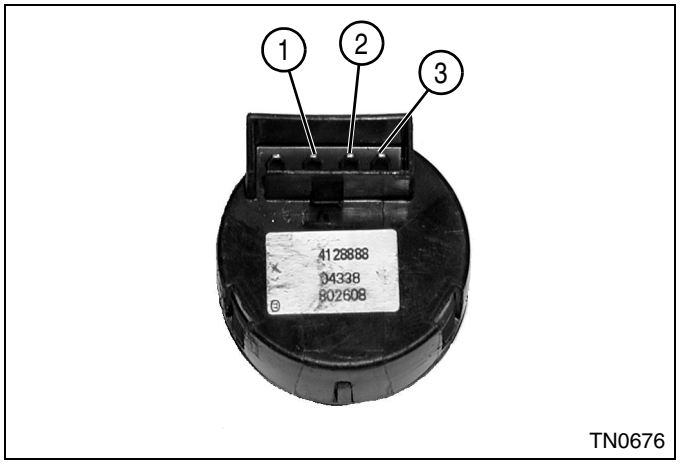

Figure 4-25

3. Move key switch to the ON position.
4. Check continuity between terminals (2 and 3).

   Is continuity indicated?

   YES *Proceed to step 5.*

   NO *The key switch is faulty.*
5. Move the key switch to the START position. Check continuity between terminals (1, 2, and 3).

   Is continuity indicated?

   YES *The key switch is good.*

   NO *The key switch is faulty; replace the switch.*
6. Install key switch.

   NO

Raise/Lower Switch Test

See Figure 4-26.

Required Tools or Equipment
Digital Multimeter, Ohmmeter, or Continuity Tester

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove the raise-lower switch from the instrument panel. (See “Raise/Lower Switch” on page 4-75.)

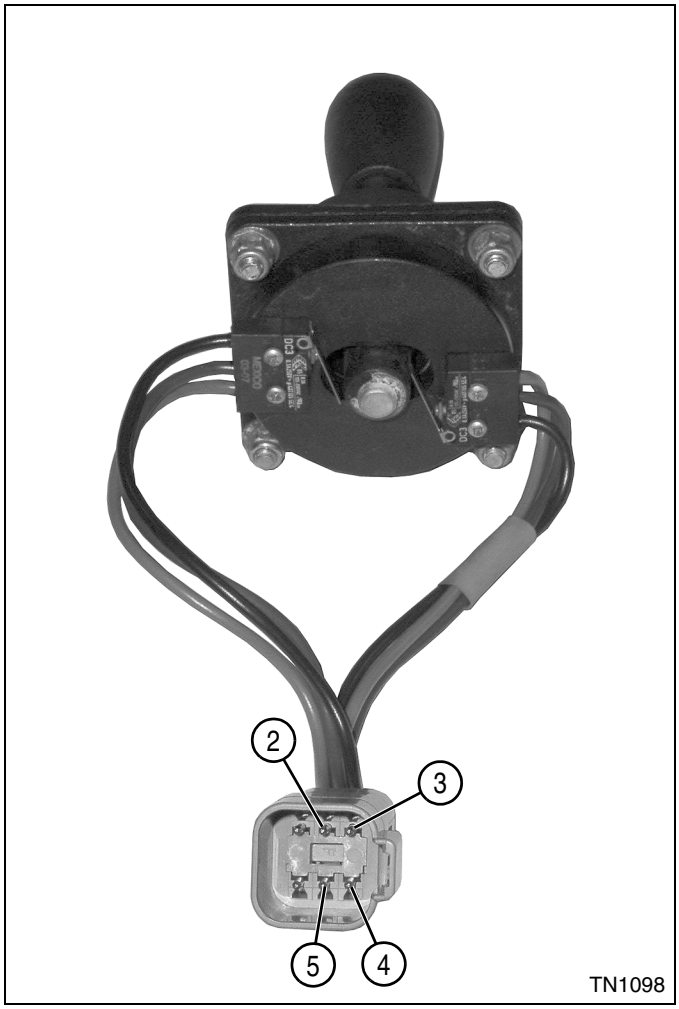

Figure 4-26

3. Connect test leads to terminals (2 and 3) and check for continuity.

   Is continuity indicated?

   YES *The switch is faulty; replace the raise-lower switch assembly.*

   NO *Proceed to step 4.*

4. With the test leads connected as described in step 3, move and hold the raise-lower lever in the lower position.
5. Check for continuity.

   Is continuity indicated?

   YES *Proceed to step 6.*

   NO *The switch is faulty; replace the raise-lower switch assembly.*

6. Return the raise-lower lever to the center (neutral) position.
7. Connect test leads to terminals (4 and 5) and check for continuity.

   Is continuity indicated?

   YES *The switch is faulty; replace the raise-lower switch assembly.*

   NO *Proceed to step 8.*

8. With the test leads connected as described in step 7, move and hold the raise-lower lever in the raise position.

   Is continuity indicated?

   YES *The raise-lower switch assembly is good.*

   NO *The switch is faulty; replace the raise-lower switch assembly.*

Traction Control Switch Test

See Figure 4-27.

Required Tools or Equipment
Digital Multimeter, Ohmmeter, or Continuity Tester

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove the traction control switch from the machine. (See “Rocker Switches” on page 4-72.)

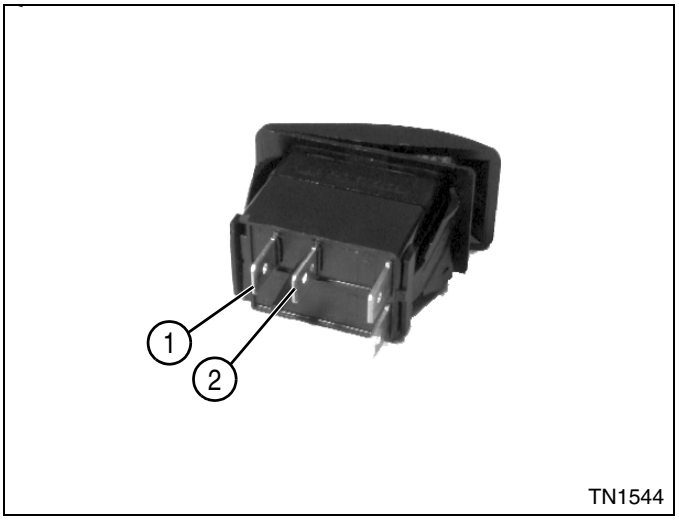

Figure 4-27

3. Connect test leads to the switch terminals (1 and 2).
4. Check for continuity.

   Is continuity indicated?

   YES *The switch is faulty; replace the switch.*

   NO *Proceed to step 5.*
5. With the test leads still connected, press the traction control switch.

   Is continuity indicated?

   YES *The switch is good.*

   NO *The switch is faulty; replace the switch.*

Light Switch Test

See Figure 4-28.

Required Tools or Equipment
Digital Multimeter, Ohmmeter, or Continuity Tester

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove the work light switch from the control panel. (See “Rocker Switches” on page 4-72.)

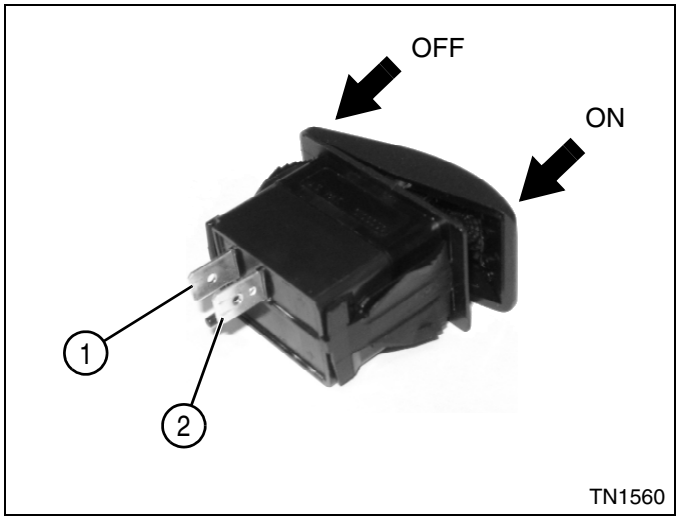

Figure 4-28

3. Place the switch in the OFF position.
4. Connect test leads to the switch terminals (1 and 2).
5. Check for continuity.

   Is continuity indicated?

   YES *The switch is faulty; replace the switch.*

   NO *Proceed to step 6.*
6. Place the switch in the ON position.

   Is continuity indicated?

   YES *The switch is good.*

   NO *The switch is faulty; replace the switch.*

Horn Switch

See Figure 4-29.

Required Tools or Equipment
Digital Multimeter, Ohmmeter, or Continuity Tester

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove the horn switch from the control panel. (See “Rocker Switches” on page 4-72.)

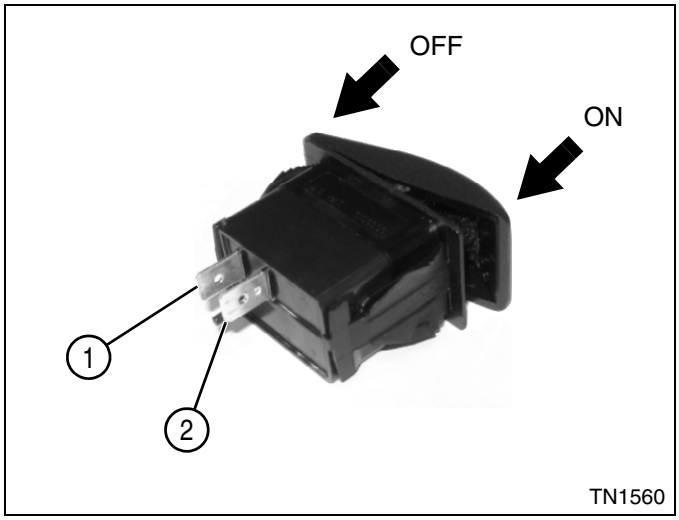

Figure 4-29

3. The switch is normally in the OFF position.
4. Connect test leads to the switch terminals (1 and 2).
5. Check for continuity.

   Is continuity indicated?

   YES *The switch is faulty; replace the switch.*

   NO *Proceed to step 6.*
6. Depress and hold the switch in the ON position.

   Is continuity indicated?

   YES *The switch is good.*

   NO *The switch is faulty; replace the switch.*

Seat Switch Test

See Figure 4-30.

Required Tools or Equipment
Digital Multimeter, Ohmmeter, or Continuity Tester

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)

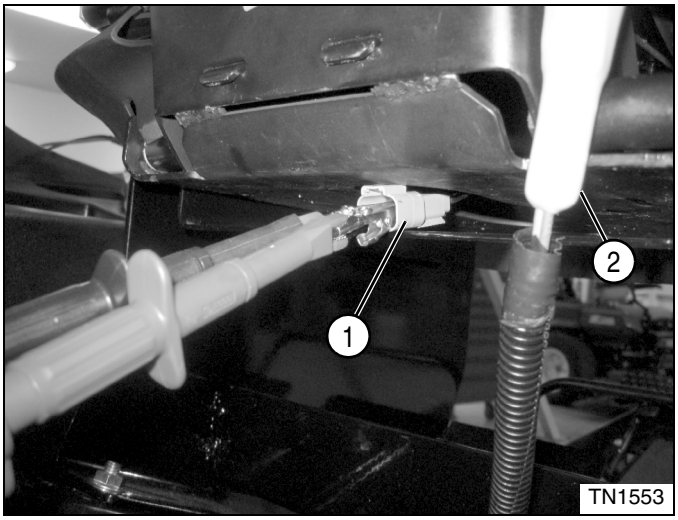

Figure 4-30

2. Unplug the seat switch (1) from the harness (2).
3. Connect test leads to the switch terminals.
4. Check for continuity.

   Is continuity indicated?

   YES *The switch is faulty; replace the switch.*

   NO *Proceed to step 5.*
5. Depress the seat switch or have a helper sit in the seat.

   Is continuity indicated?

   YES *The switch is good.*

   NO *The switch is faulty; replace the switch.*

Hydraulic Oil Level Switch Test

See Figures 4-31 and 4-32.

Required Tools or Equipment
Digital Multimeter, Ohmmeter, or Continuity Tester

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Check to make sure hydraulic oil is at the correct level.
3. Remove the cover from the top of the hydraulic oil tank.
4. Remove the hydraulic oil level switch from the hydraulic oil tank.

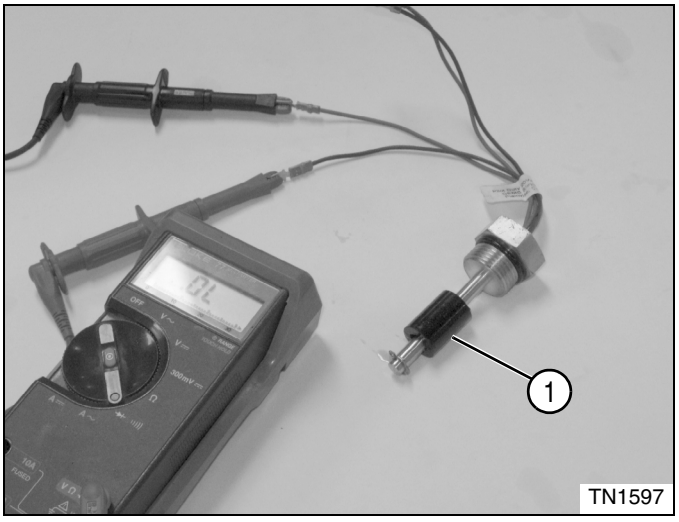

Figure 4-31

5. Connect test leads to the red and black switch terminals.
6. Push the float (1) to the up position.
7. Check for continuity.

Is continuity indicated?

YES *The hydraulic oil level switch is faulty; replace the switch.*

NO *Proceed to step 8.*

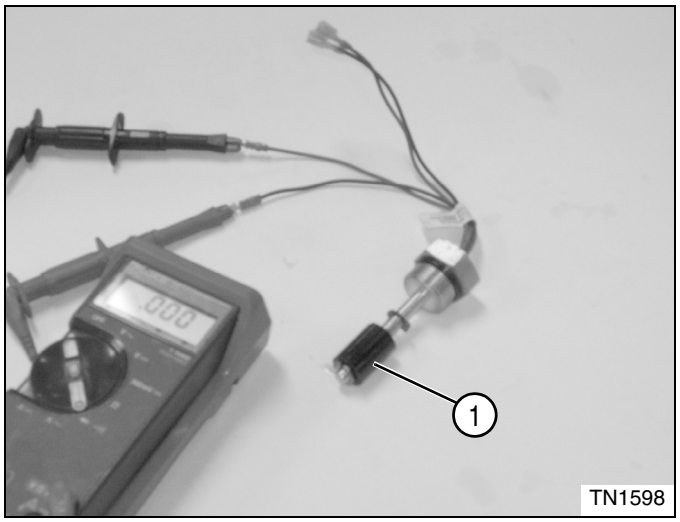

Figure 4-32

8. Push the float (1) to the down position.
9. Check for continuity.

Is continuity indicated?

YES *The hydraulic oil level switch is good.*

NO *The hydraulic oil level switch is faulty; replace the switch.*

Mow Switch

See Figures 4-33 and 4-34.

Required Tools or Equipment
Digital Multimeter or Ohmmeter

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove the instrument panel. (See “Instrument Panel” on page 4-71.)

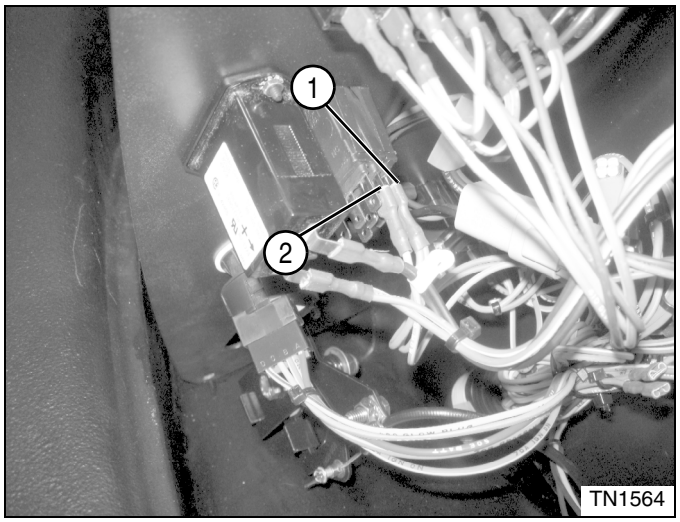

Figure 4-33

3. With the ignition key turned to the ON position, use a multimeter to check for battery voltage at the orange/pink wire (1).
4. Battery voltage should be available at terminal (1). If not, check the wiring harness for loose, broken, or dirty connections.
5. Remove the wire connectors from the switch terminals.
6. Remove the mow switch from the control panel.

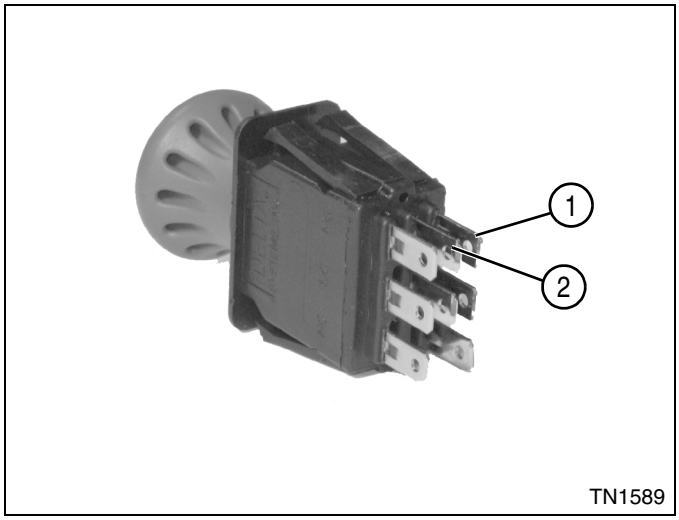

Figure 4-34

7. Place test leads on switch terminals (1 and 2).
8. Place the switch in the ON (pulled up) position.
9. Check for continuity.

Is continuity indicated?

YES *The switch is good.*

NO *The switch is faulty; replace the switch.*

10. Place the switch in the OFF (push down) position.

Is continuity indicated?

YES *The switch is faulty; replace the switch.*

NO *The switch is good.*

Solenoid Test

See Figure 4-35.

Required Tools or Equipment
Digital Multimeter or Ohmmeter

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)

NOTE

This procedure applies to the following solenoid coils:

- *Mow Solenoid*
- *Raise Solenoid*
- *Lower Solenoid*

2. Locate the component solenoid to be tested. Remove the solenoid coil from the machine. (See “Solenoid Coils” on page 4-76.)

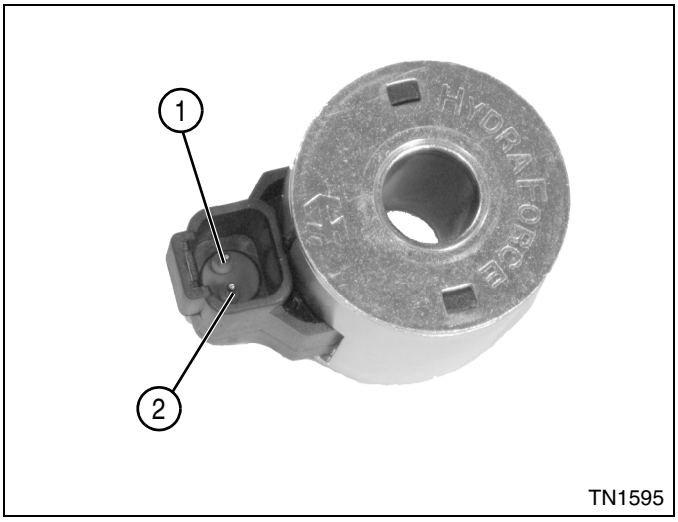

Figure 4-35

NOTE

On some meters it will be necessary to select a range for the solenoid being tested.

3. Using a multimeter or ohmmeter, measure the ohms resistance between terminals (1 and 2). Refer to the specifications listed for the specific solenoid voltage.

- Raise Solenoid Coil—7.0 ohms ± 10% at 68°F
- Lower Solenoid Coil—6.0 ohms ± 10% at 68°F
- Mow Solenoid Coil—9.8 ohms ± 10% at 68°F

Does the resistance through the component match the specified value listed?

YES *The solenoid is good.*

NO *The solenoid is faulty; replace the solenoid.*

Hydraulic Filter Pressure Switch Test

See Figure 4-36.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Shut down the engine and remove the ignition key.
3. Set the multimeter to the continuity setting.

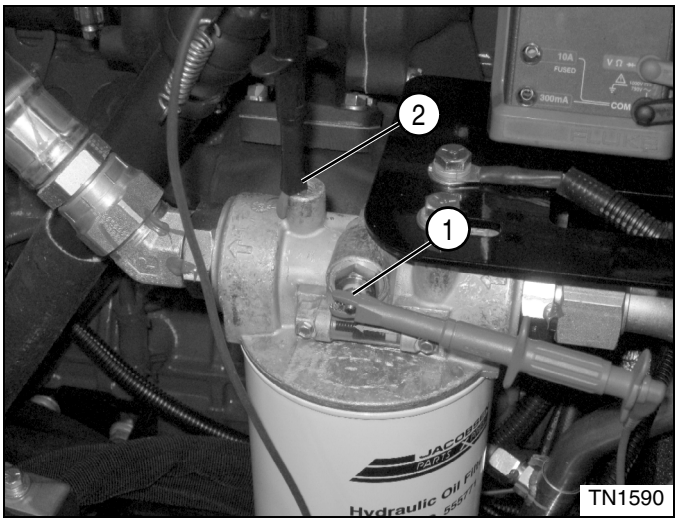

Figure 4-36

4. Remove the sender wire from the switch.
5. Place one test lead on the switch stud (1).
6. Place the other test lead on the filter head (2).

Is continuity indicated?

YES *The switch is faulty; replace the switch.*

NO *The switch is good.*

Engine Oil Pressure Switch Test

See Figure 4-37.

Required Tools or Equipment
Digital Multimeter, Ohmmeter, or Continuity Tester

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Check the engine oil level. Add oil as needed. (Refer to “Safety, Operation & Maintenance Manual” for oil specification.)

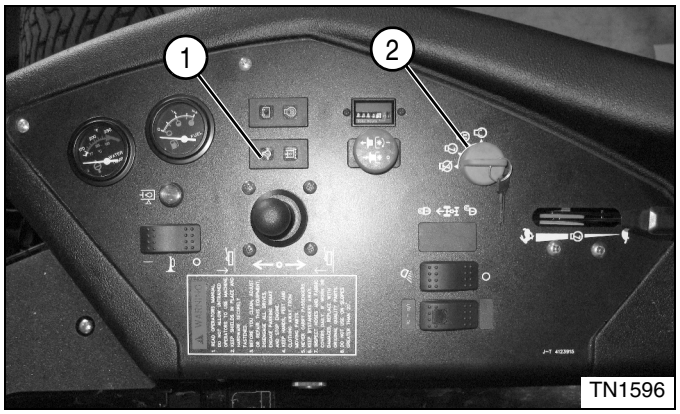

Figure 4-37

3. Turn the key switch (2) to the run position.

Does the engine oil pressure warning light (1) come on?

YES *Proceed to step 4.*

NO *Check the instrumentation Circuit. (See “Instrumentation Circuit Schematic” on page 4-40.)*

4. Start the engine. (Refer to “Safety, Operation & Maintenance Manual”.)

Does the engine oil pressure warning light (1) go out when the engine is running?

YES *The warning light is good.*

NO *Stop the engine immediately and check the engine. (Refer to the engine manufacturer’s manual.)*

Fuel Level Sensor Test

See Figure 4-38.

Required Tools or Equipment
Digital Multimeter, Ohmmeter, or Continuity Tester

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove the fuel level sensor from the fuel tank. (See “Fuel Tank” on page 9-6.)

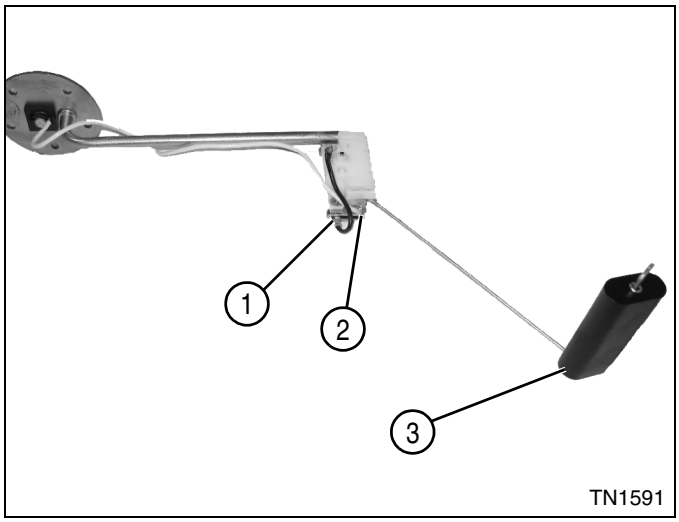

Figure 4-38

NOTE

Float shown in the empty position.

3. Connect the test leads to terminals (1 and 2).
4. Set the meter to read ohms.
5. Move the float (3) to the empty position and read the resistance value.

   Is the resistance value between 211 and 286 ohms?

   YES *Proceed to step 6.*

   NO *The sensor is faulty; replace fuel level sensor.*

6. Move the float (3) to the full position and read the resistance value.

   Is the resistance value between 26 and 35 ohms?

   YES *The sensor is good.*

   NO *The sensor is faulty; replace fuel level sensor.*

Circuit Breaker Test

See Figure 4-39.

Required Tools or Equipment
Digital Multimeter, Ohmmeter, or Continuity Tester

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Allow engine to cool completely.
3. Set the multimeter to 20 volts DC.
4. Connect the black test lead to the negative (–) battery terminal.

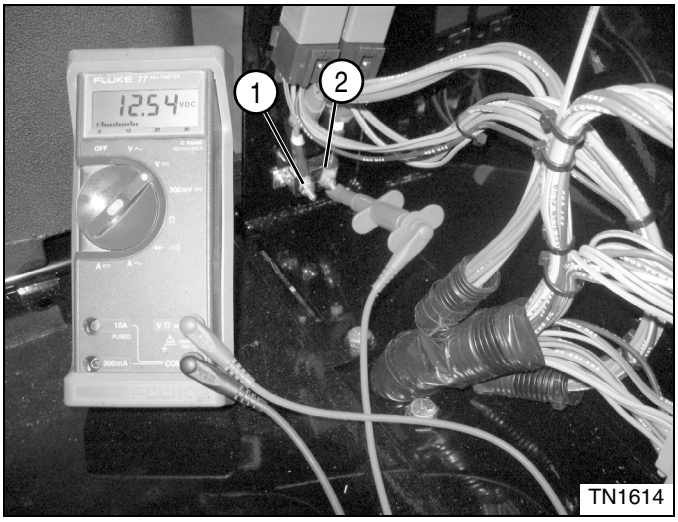

Figure 4-39

5. Connect the red test lead to each of the circuit breaker terminals (1 and 2).

   Is battery voltage indicated?

   YES *Circuit breaker is good.*

   NO *Circuit breaker is faulty; replace circuit breaker.*

Fuel Pump Test

See Figures 4-40 and 4-41

Required Tools or Equipment
Digital Multimeter, Ohmmeter, or Continuity Tester

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Allow engine to cool completely.

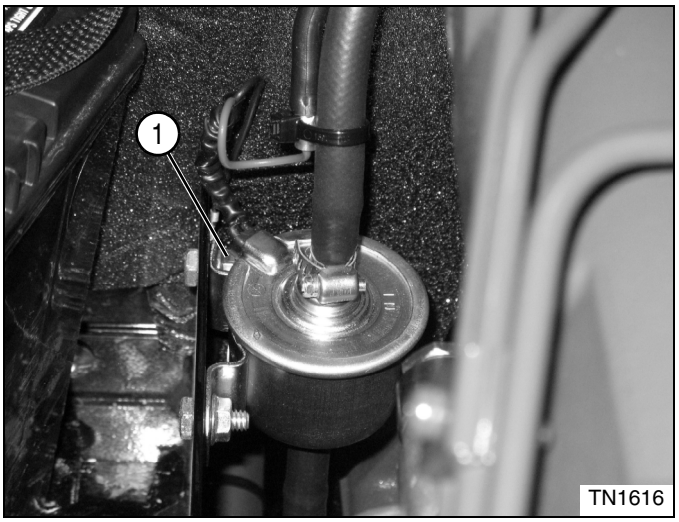

Figure 4-40

3. Connect the red test lead to the black fuel pump ground wire (1).
4. Connect the black test lead to the negative (–) battery terminal.
5. Check for continuity.

Is continuity indicated?

YES *Proceed to step 6.*

NO *Check for proper ground at the pump.*

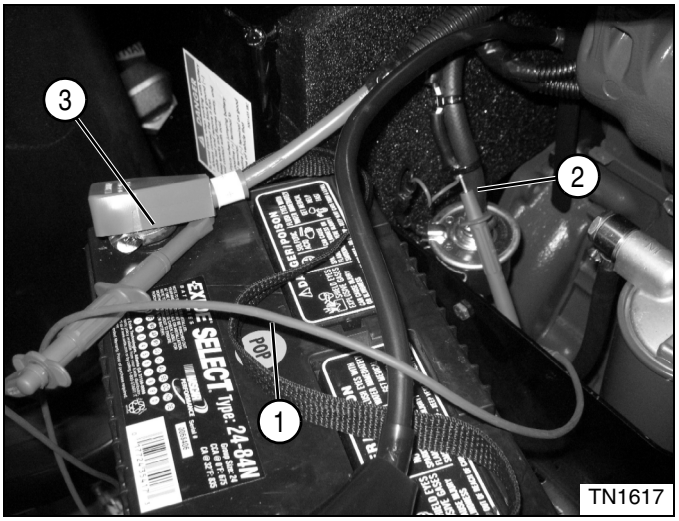

Figure 4-41

6. Using a jumper wire (1), connect one end to the power wire (2) pump side.
7. Touch the other end of the jumper to the positive (+) battery terminal (3).

Does the fuel pump start?

YES *The pump is good.*

NO *The pump is faulty; replace the pump.*

Repair

Battery and Battery Tray

Removal and Installation

See Figures 4-42 and 4-43.

WARNING

- **Battery posts, terminals, and related accessories contain lead and lead compounds. Wash your hands after handling.**
- **Always wear eye protection when servicing battery.**

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Raise the hood.

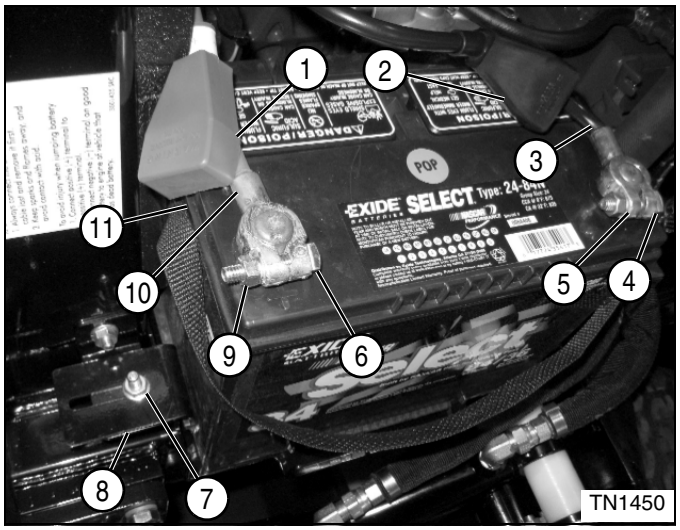

Figure 4-42

WARNING

Always disconnect the negative terminal first and positive terminal last. Connect positive terminal first and negative terminal last. Use care when testing live circuits to prevent arcing. Arcing could result in death or serious injury.

3. Remove nut (3) and screw (4), and disconnect the negative (–) battery cable (5).
4. Remove the nut (9) and screw (6), and disconnect the positive (+) battery cable (10).
5. Remove nut (7) and screw (not shown) and retainer bracket (8) from the battery tray.

NOTICE

Never place used batteries in the garbage. Dispose of used batteries in accordance with all applicable regulations.

6. Remove the battery (11).

NOTE

Perform steps 8 through 13 if the battery tray is to be removed.

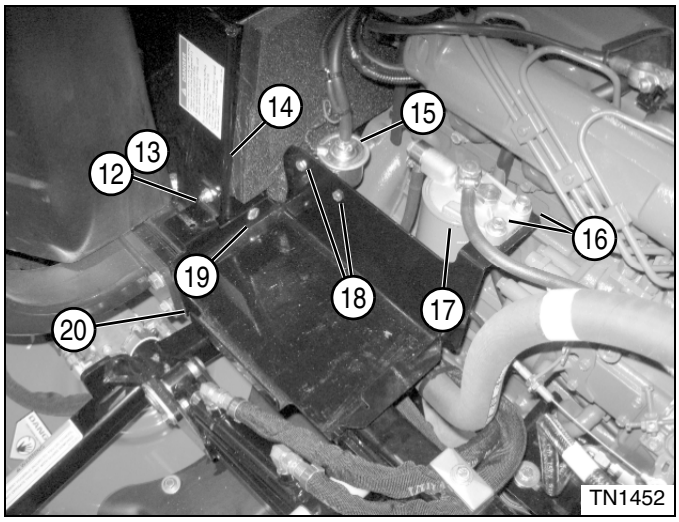

Figure 4-43

7. Support the battery tray (20).
8. Remove nut (12) and screw (13) from the controller support (14) and battery tray (20).
9. Remove screw (19) and nut (not shown) from the controller support (14) and battery tray (20).
10. Support the fuel solenoid (15). Remove screws (18) and nuts (not shown) from the battery tray (20) and fuel solenoid (15).
11. Support the fuel filter assembly (17). Remove nuts (16) and screws (not shown) from the fuel filter assembly (17) and battery tray (20).
12. Remove the battery tray (20).

Installation Note

Install the battery tray and battery by reversing the order of removal.

Alternator

Removal and Installation

See Figures 4-44 and 4-45.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Raise the hood.
3. Disconnect the negative (–) battery cable at the battery.

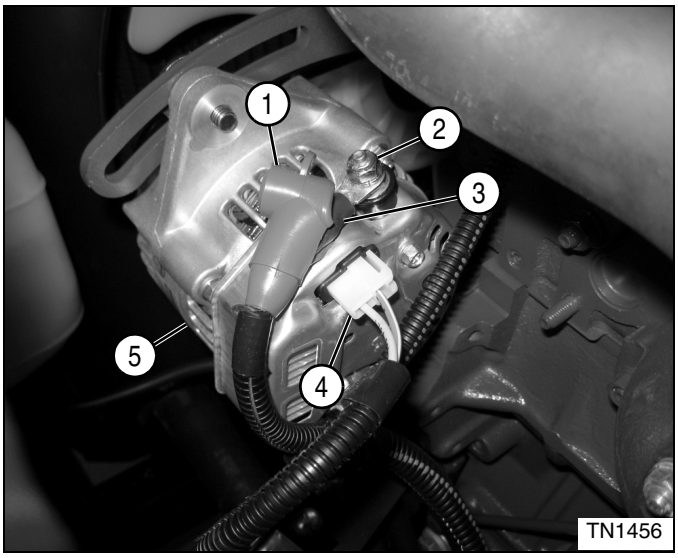

Figure 4-44

4. Remove the boot (1) from the terminal, and slide it down the wire.

NOTE

Label all wires before disconnecting to ensure correct installation.

5. Remove lock nut (2) and disconnect wire (3) from terminal.
6. Disconnect wiring connector block (4) from the alternator (5).

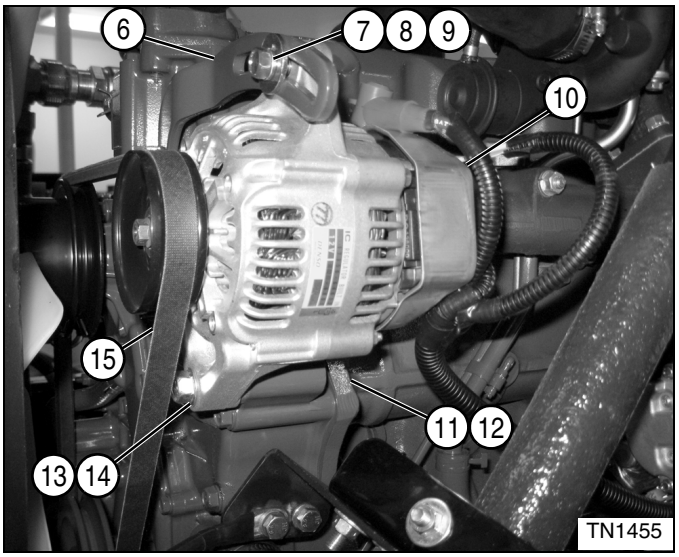

Figure 4-45

7. Loosen screw (6) and push the alternator (10) toward the engine.
8. Remove the fan drive belt (15).
9. Support the alternator (10).
10. Remove screw (7), lock washer (8), and flat washer (9) from the upper bracket (6) and alternator (10).
11. Remove nut (11), lock washer (12), screw (13), and flat washer (14), and remove alternator (10).

Installation Notes

- *Install the alternator by reversing the order of removal.*
- *Adjust fan belt tension. (Refer to "Safety, Operation & Maintenance Manual".)*

Starter Motor

Removal and Installation

See Figures 4-46 and 4-47.

1. Park the mower safely. (See "Park Mower Safely" on page 1-5.)
2. Raise the hood.
3. Disconnect the negative (–) battery cable at the battery.

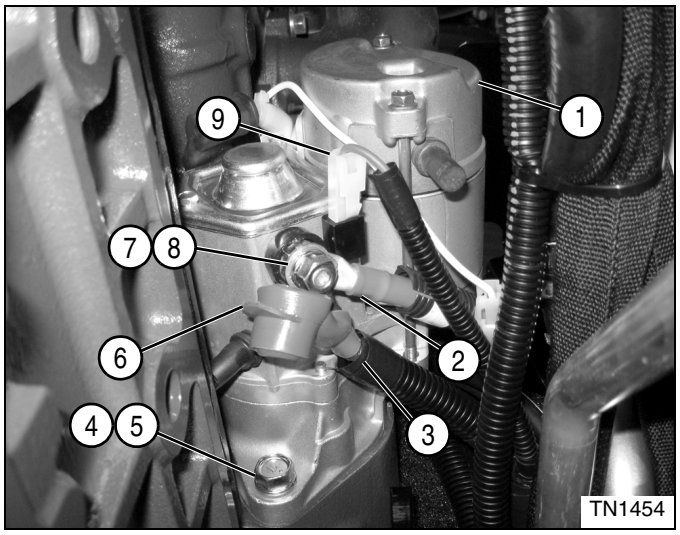

Figure 4-46

4. Remove the boot (6) from the terminal, and slide it down the wire (3).

NOTE

Label all wires before disconnecting to ensure correct installation.

5. Remove nut (7) and lock washer (8), and disconnect wires (2 and 3) from terminal.
6. Disconnect wiring connector (9) from the starter motor (1).
7. Support the starter motor (1).
8. Remove screw (4) and lock washer (5).

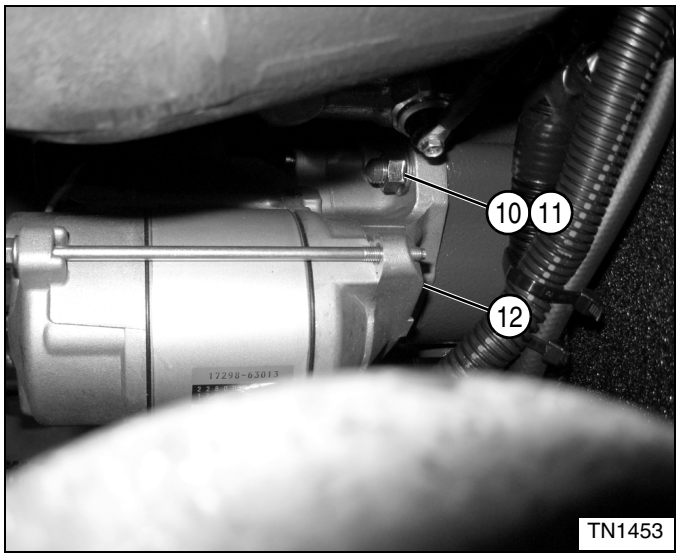

Figure 4-47

9. Remove socket-head screw (10) and lock washer (11), and remove the starter motor (12).

Installation Note

Install the starter motor by reversing the order of removal.

Plug-In Fuses

Removal and Installation

See Figures 4-48 and 4-49.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Raise the hood.
3. Disconnect the negative (–) battery cable at the battery.

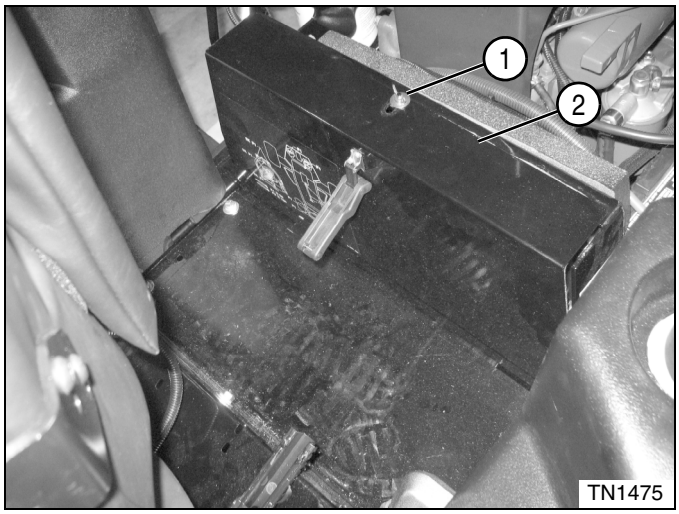

Figure 4-48

4. Move seat forward, loosen wing nut (1), and open control module cover (2).

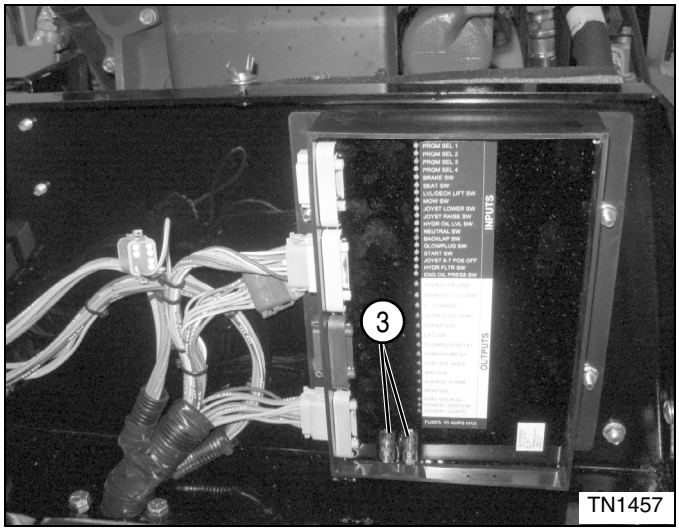

Figure 4-49

5. Remove fuse(s) (3) by pulling the fuse(s) straight out of the fuse holder.

Installation Note

Install plug-in fuse(s) by reversing the order of removal.

Circuit Breaker

Removal and Installation

See Figures 4-50 and 4-51.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Raise the hood.
3. Disconnect the negative (–) battery cable at the battery.

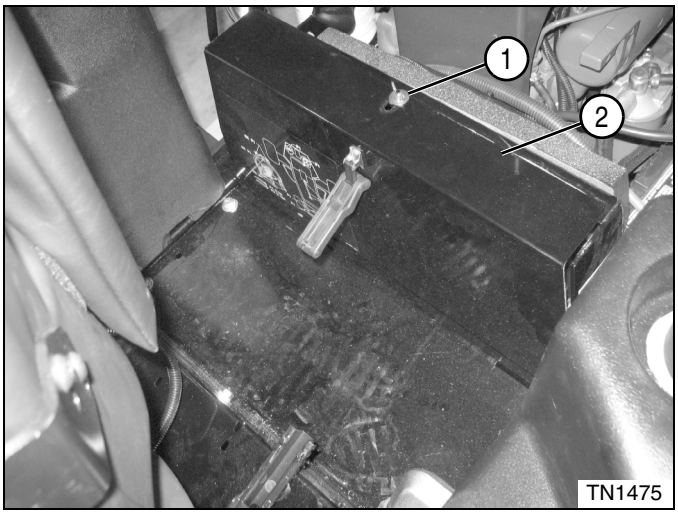

Figure 4-50

4. Move seat forward, loosen wing nut (1), and open control module cover (2).

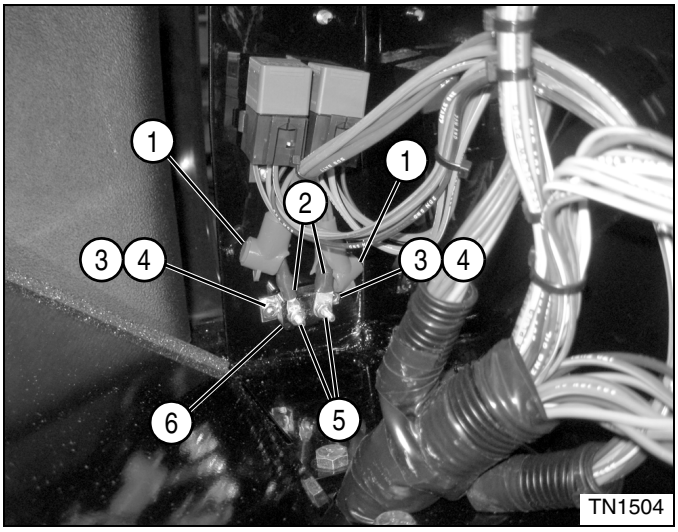

Figure 4-51

5. Remove the boot (1) from the terminal and slide it up the wire (2).
6. Remove nut (5) for wiring connection.
7. Remove two nuts (3) and screws (4).
8. Remove circuit breaker (6).

Start Relay

Removal and Installation

See Figures 4-52 and 4-53.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Raise the hood.
3. Disconnect the negative (–) battery cable at the battery.

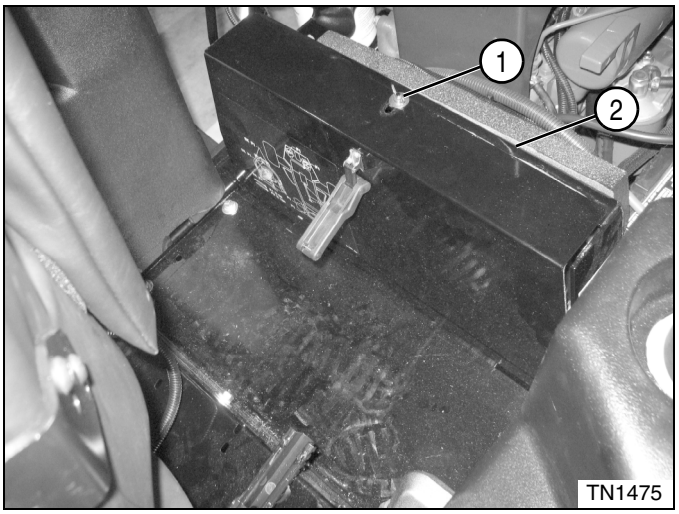

Figure 4-52

4. Move seat forward, loosen wing nut (1), and open control module cover (2).

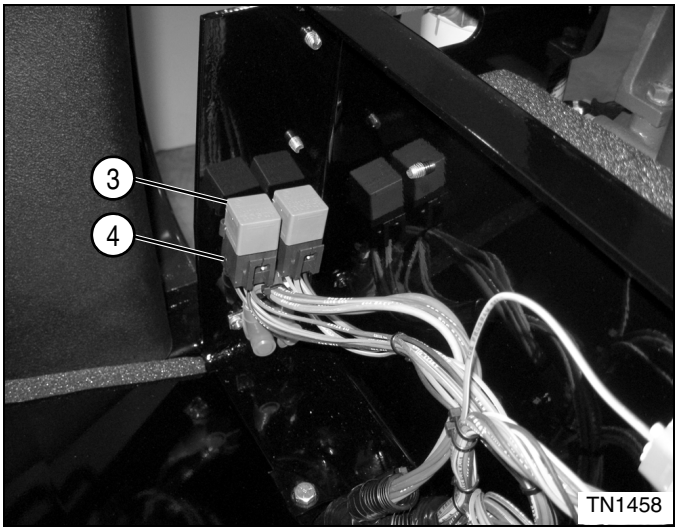

Figure 4-53

5. Pull the relay (3) straight up and out of the relay base (4).

Installation Note

Install the start relay by reversing the order of removal.

Glow Plug Relay

Removal and Installation

See Figures 4-54 and 4-55.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Raise the hood.
3. Disconnect the negative (–) battery cable at the battery.

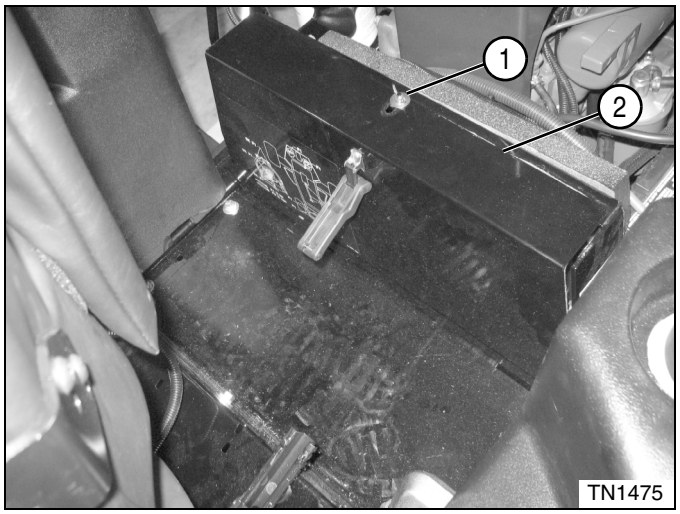

Figure 4-54

Move seat forward, loosen wing nut (1), and open control module cover (2).

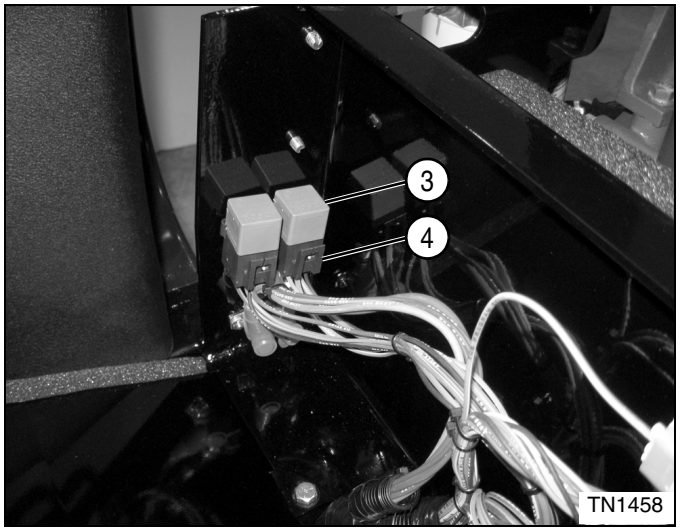

Figure 4-55

4. Pull the relay (3) straight up and out of the relay base (4).

Installation Note

Install the glow plug relay by reversing the order of removal.

Instrument Panel

Removal and Installation

See Figure .

NOTE

If servicing individual components, it is not necessary to completely remove the instrument panel. In these cases, the instrument panel can be moved aside for access to components.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)

NOTE

Label all wires before disconnecting to ensure correct installation.

2. Disconnect the negative (–) battery cable at the battery.
3. If removing the instrument panel, disconnect the positive (+) battery cables from the battery.

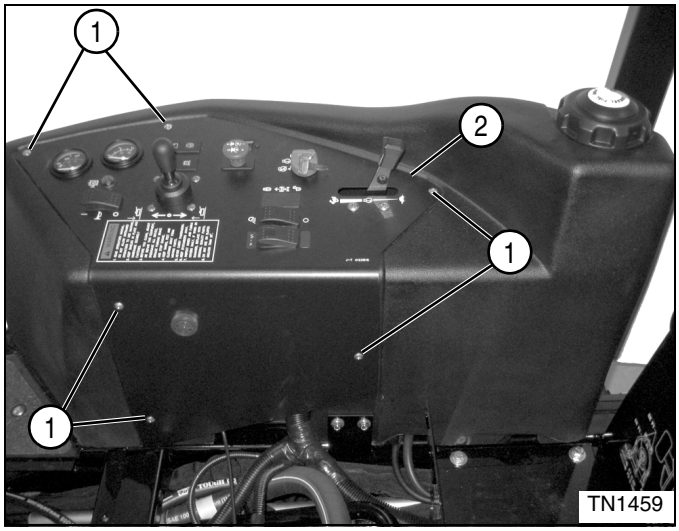

Figure 4-56

NOTES

- *Seat removed for photo clarity.*
- *If moving the instrument panel aside, use caution to prevent stretching or kinking of the cables.*

4. Remove six screws (1) and move the panel (2) aside, or service components as needed.

Installation Notes

- *Anti-Seize must be applied to screw threads when installing instrument panel.*
- *Install the instrument panel by reversing the order of removal.*

Key Switch

Removal and Installation

See Figures 4-57 and 4-58.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Disconnect the negative (–) battery cable at the battery.
3. Remove instrument panel. (See “Instrument Panel” on page 4-71.)

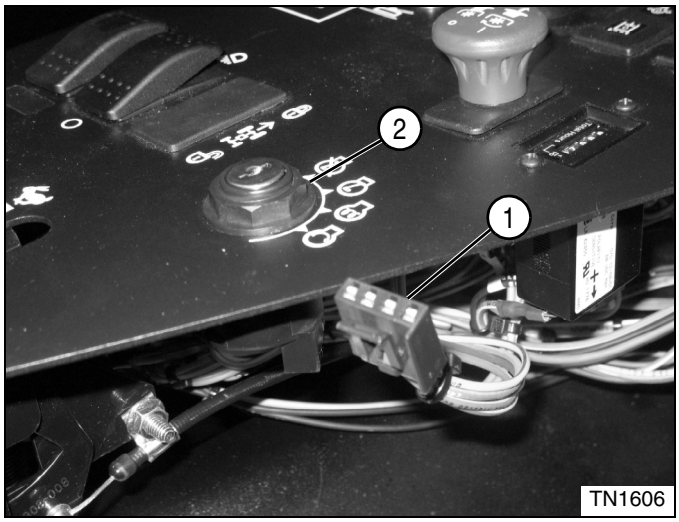

Figure 4-57

4. Disconnect the key switch wiring harness (1).
5. Remove retaining nut (2) from the key switch assembly.

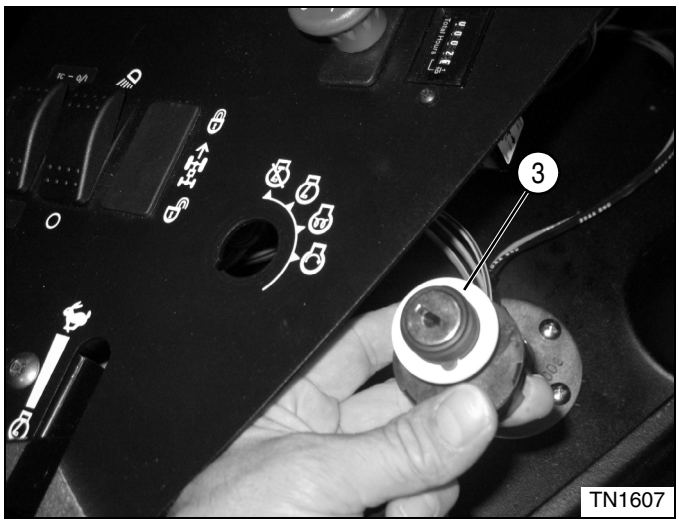

Figure 4-58

6. Remove key switch assembly (3) from bottom of the instrument panel.

Installation Note

Install the key switch by reversing the order of removal.

Rocker Switches

See Figure 4-59.

Figure 4-59

This procedure applies to the following switches:

- Traction Control Switch (1)
- Work Light Switch (2)
- Horn Switch (3)

Removal and Installation

See Figure 4-60.

NOTE

Horn switch shown.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Disconnect the battery negative (–) cable at the battery.
3. Remove the instrument panel. (See “Instrument Panel” on page 4-71.)

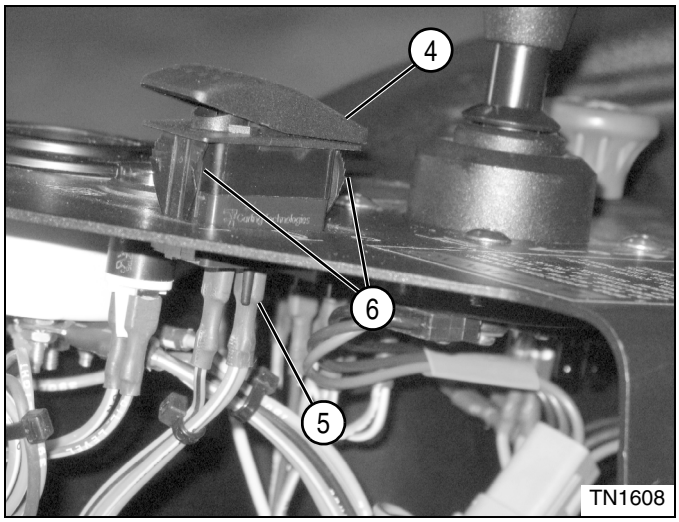

Figure 4-60

4. Disconnect the switch (4) from the connector wires (5).
5. Depress tabs (6) on each side of the rocker switch and lift out of the instrument panel.

Installation Note

Install the rocker switches by reversing the order of removal.

Indicator Lamps

See Figure 4-61.

Figure 4-61

This procedure applies to the following indicator lamps:

- Engine Preheat/Charge Warning Lamps (1)
- Restricted Hydraulic Filter Warning/Engine Temperature Warning Lamps (2)

Removal and installation

See Figures 4-62 and 4-63.

NOTE

Restricted *hydraulic filter warning/engine temperature warning module shown.*

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Disconnect the negative (–) battery cable at the battery.
3. Remove the instrument panel. (See “Instrument Panel” on page 4-71.)

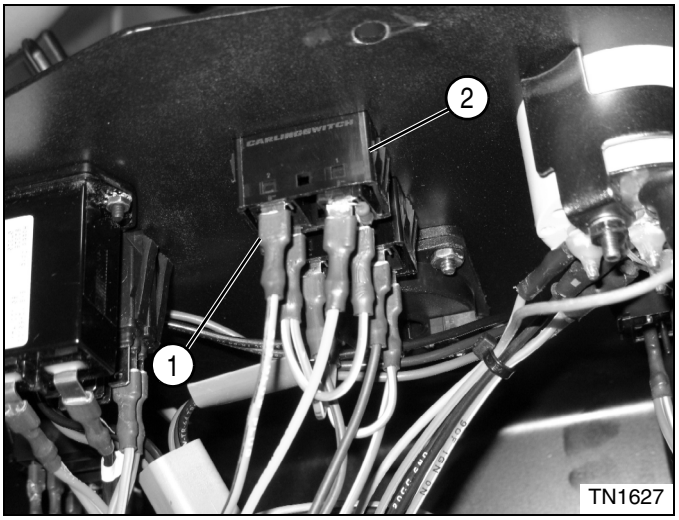

Figure 4-62

NOTE

Label all wiring connectors and note their location before removing to ensure correct installation.

4. Disconnect wiring connectors (1) from the indicator lamp module (2).

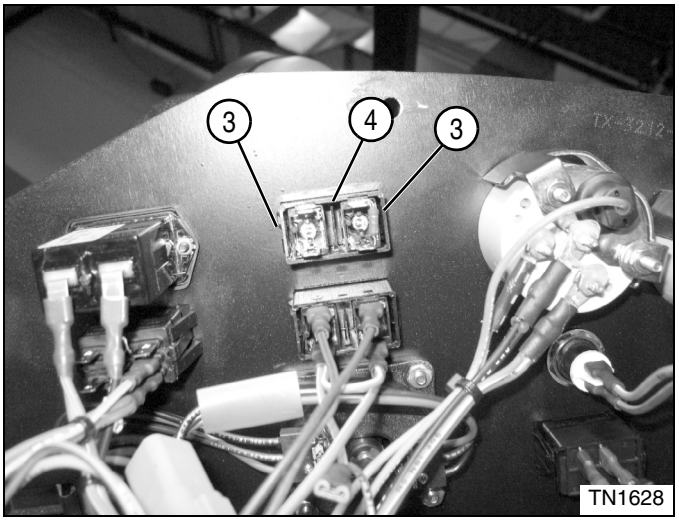

Figure 4-63

5. Press in on tabs (3) on each side of the indicator lamp module (4), and push module up through the instrument panel.

Installation Note

Install indicator lamp modules by reversing the order of removal.

Park Brake Proximity Switch

Removal and Installation

See Figures 4-64 and 4-65.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Disconnect the negative (–) battery cable at the battery.

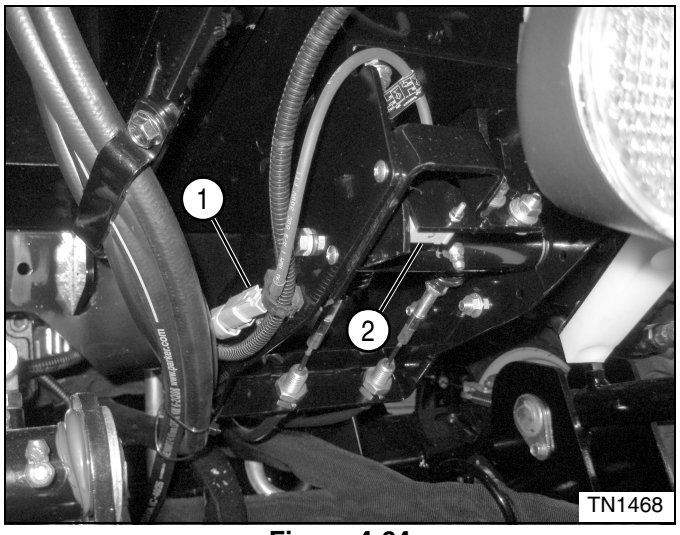

Figure 4-64

3. Disconnect the wiring connector (1) for the park brake proximity switch (2).

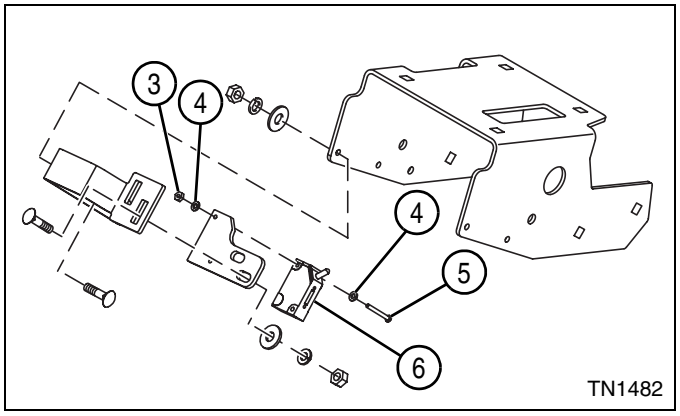

Figure 4-65

4. Remove two nuts (3), four washers (4), and two screws (5).

5. Remove park brake proximity switch (6).

Installation Note

Install the park brake proximity switch by reversing the order of removal.

Raise/Lower Switch

Removal and Installation

See Figures 4-66 and 4-67.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Disconnect the negative (–) battery cable at the battery.
3. Remove the instrument panel. (See “Instrument Panel” on page 4-71.)

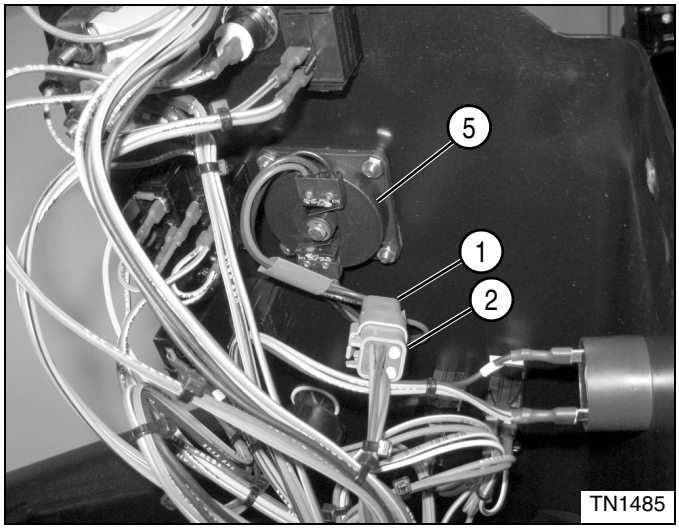

Figure 4-66

NOTE

Label all wiring connectors and record orientation of the joystick before removing to ensure correct installation.

4. Disconnect the joystick wiring connector (1) from the wiring harness (2).

NOTE

When removed, the joystick may come out as two separate pieces. If the joystick is to be tested after removal, connect the two pieces using the mounting hardware.

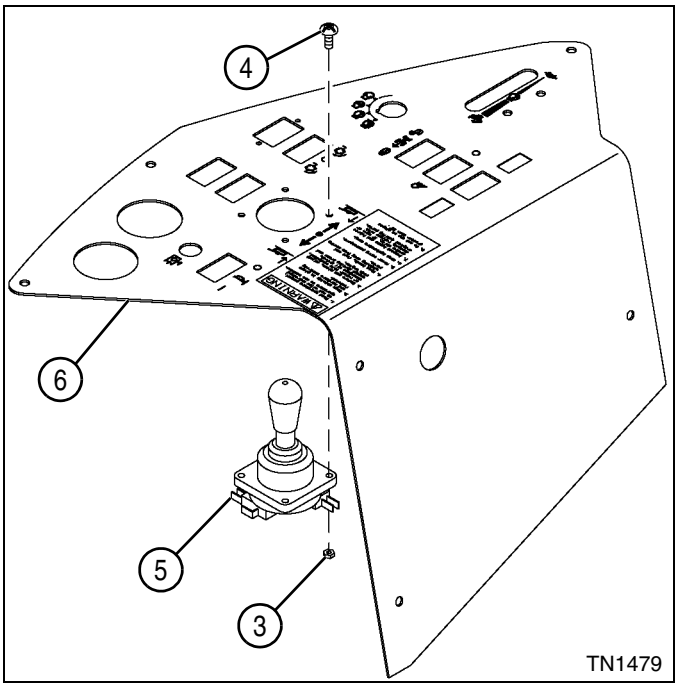

Figure 4-67

5. Remove four nuts (3) and screws (4), and remove joystick (5) from instrument panel (6).

Installation Note

Install the joystick by reversing the order of removal.

Seat Switch

Removal and Installation

The seat switch removal and installation is included in the seat and mount plate removal and installation procedure. (See “Seat and Mount Plate” on page 9-10.)

Neutral Proximity Switch

Removal and Installation

See Figures 4-68 and 4-69.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Disconnect the negative (–) battery cable at the battery.

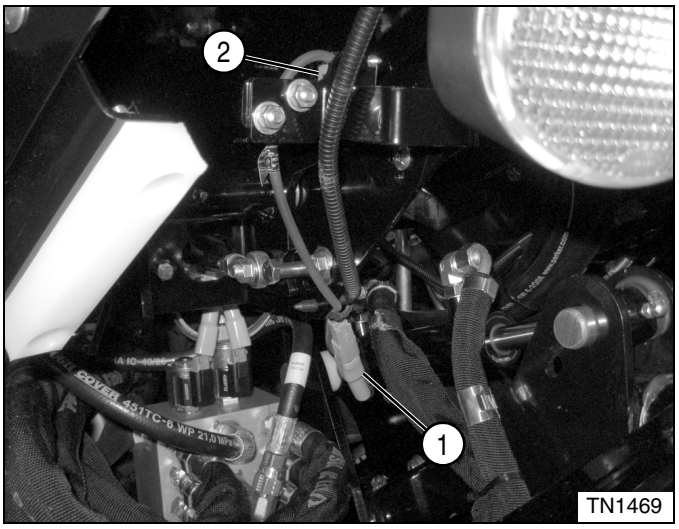

Figure 4-68

3. Disconnect the wiring connector (1) for the neutral proximity switch (2).

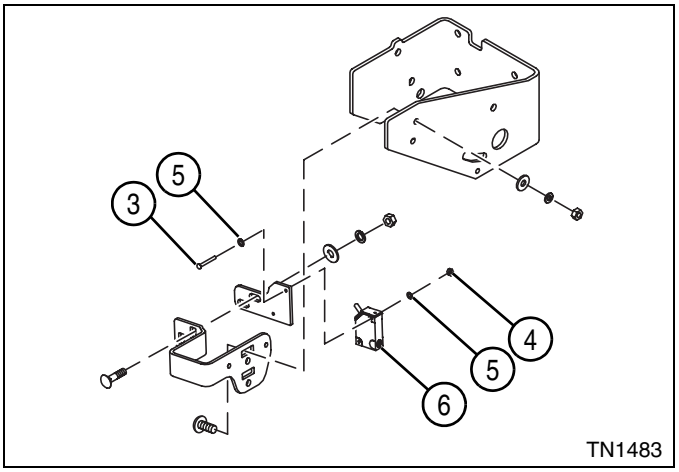

Figure 4-69

4. Remove two screws (3), four washers (5), and two nuts (4), and remove neutral proximity switch (6).

Installation Note

Install the neutral proximity switch by reversing the order of removal.

Solenoid Coils

See Figures 4-70 and 4-71.

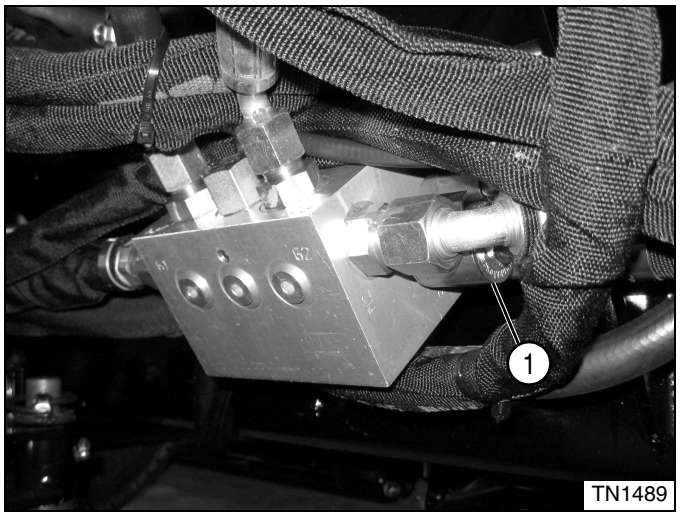

Figure 4-70: Mow Solenoid Coil

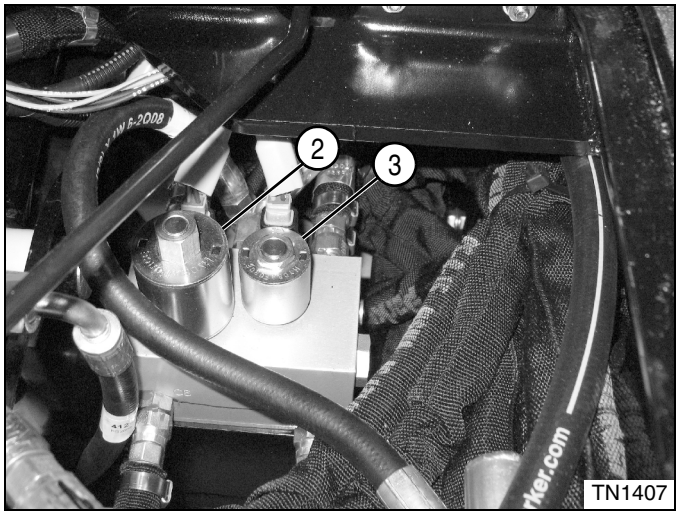

Figure 4-71: Raise and Lower Solenoid Coils

This procedure applies to the following solenoid coils:

- Mow Solenoid Coil (1)
- Raise Solenoid Coil (2)
- Lower Solenoid Coil (3)

The mow solenoid coil is located under the front axle.

The raise and lower solenoid coils are located under the center floorboard.

Removal and Installation

See Figure 4-72.

NOTE

The raise and lower solenoid coils are shown; all solenoids are removed and installed the same way.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove the center floorboard (raise and lower solenoid coils) or locate deck valve beneath front axle.
3. Disconnect the negative (–) battery cable at the battery.

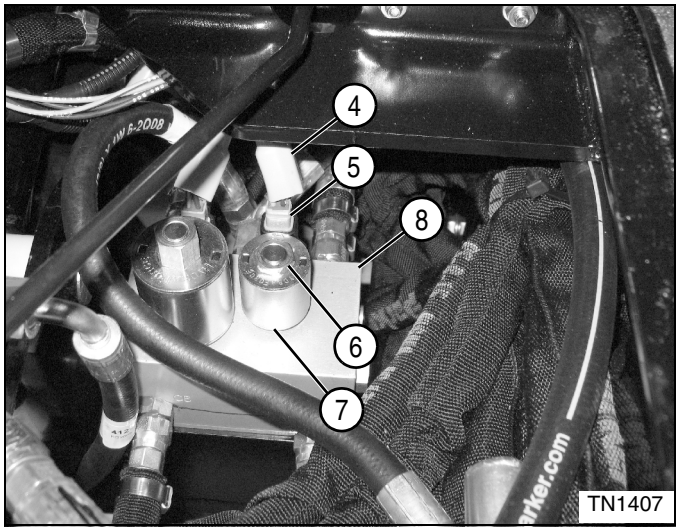

Figure 4-72

NOTE

Label connectors before disconnecting to ensure correct installation.

4. Remove the boot (4), and slide it back over the wire, and disconnect connector (5) from solenoid coil.
5. Remove nut (6), and remove the solenoid coil (7) from the valve (8).

Installation Notes

- *Install the solenoid coils by reversing the order of removal.*
- *Tighten nut (6) to 7-10 lb-in. (0.7-0.10 N·m).*

Fuel Solenoid

Removal and Installation

See Figure 4-73.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Raise the hood.
3. Disconnect the negative (–) battery cable at the battery.

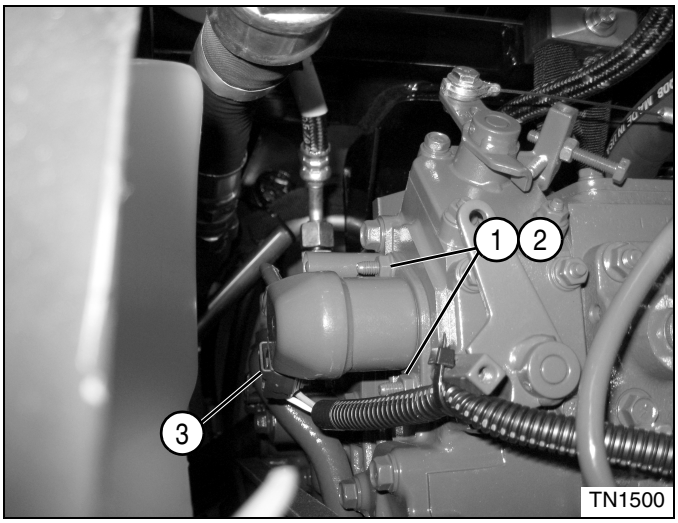

Figure 4-73

4. Disconnect the solenoid electrical connector (3).
5. Remove two nuts (1) and washers (2).
6. Remove solenoid.

Installation Note

Install the fuel shutoff solenoid by reversing the order of removal.

Hydraulic Oil Filter Switch

Removal and Installation

See Figure 4-74.

WARNING

The hydraulic system is under pressure, and the oil may be hot!

- **Always allow the machine to cool completely before performing service.**
- **Always relieve pressure in the hydraulic system before performing service.**
- **Always use appropriate safety equipment and clothing to protect exposed skin and eyes from high-pressure oil.**
- **Tighten all connections to proper specifications before applying pressure.**
- **Never use bare hands to check for leaks! Oil under pressure can penetrate the skin and can cause gangrene within a few hours if not properly removed. Use a piece of cardboard to check for leaks.**

Failure to follow appropriate safety precautions may result in death or serious injury.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Raise the hood.
3. Disconnect the negative (–) battery cable at the battery.

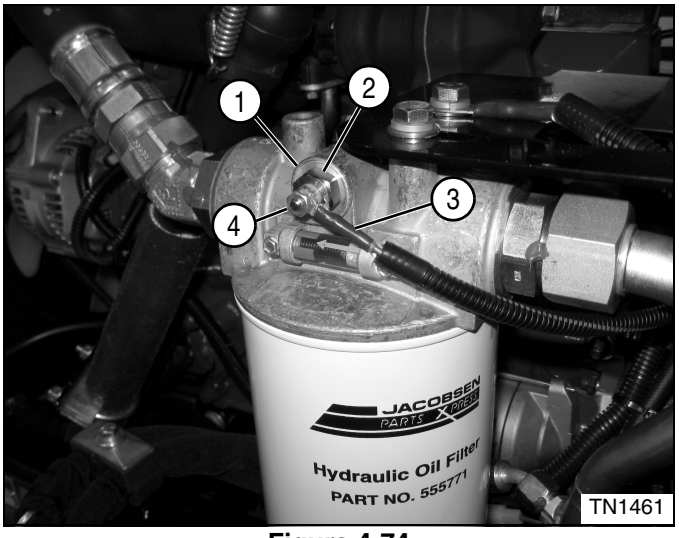

Figure 4-74

4. Remove nut (4), and disconnect wire (3) from the hydraulic filter switch (2).
5. Remove the hydraulic filter switch (2) from the filter head (1).

Installation Notes

Required Materials
Telfon® Tape

- *Install the hydraulic filter switch by reversing the order of removal.*
- *Apply Teflon® tape to the threads of the hydraulic filter switch before installing.*

Engine Oil Pressure Switch

Removal and Installation

See Figure 4-75.

CAUTION

Engine components will become hot during operation. Allow engine components to cool before performing service.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Raise hood.
3. Disconnect the negative (–) battery cable at the battery.

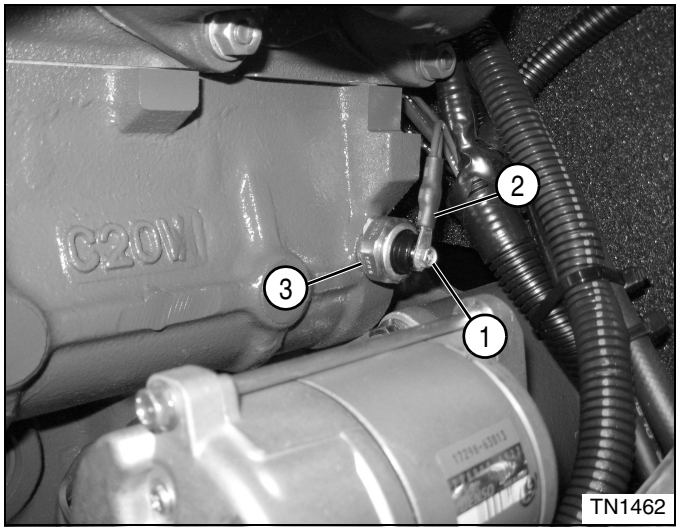

Figure 4-75

NOTE

Label all wires before disconnecting to ensure correct installation.

4. Remove screw (1), and disconnect wire (2) from the oil pressure switch (3).
5. Remove the oil pressure switch (3) from the engine block.

Installation Notes

Required Materials
Telfon® Tape

- *Install the engine oil pressure switch by reversing the order of removal.*
- *Apply Teflon® tape to the threads of the oil pressure switch before installing.*

Engine Temperature Switch

Removal and Installation

See Figure 4-76.

WARNING

Engine coolant is hot and under pressure! Allow the cooling system to cool completely before performing service.

Rotate the filler cap 1/2-turn counterclockwise and allow pressure to vent before removing filler cap.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Raise the hood.
3. Disconnect the negative (–) battery cable at the battery.

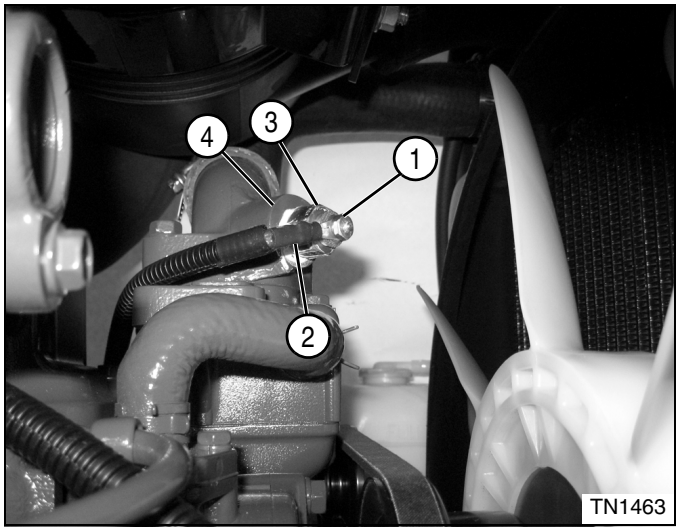

Figure 4-76

NOTE

Label all wires before disconnecting to ensure correct installation.

4. Remove nut (1), and disconnect wire (2) from the engine temperature switch (3).
5. Remove the engine temperature switch (3) from the thermostat housing (4).

Installation Notes

Required Materials
Telfon® Tape

- *Install the engine temperature switch by reversing the order of removal.*
- *Apply Teflon® tape to the threads of the engine temperature switch before installing.*

Control Module

Removal and Installation

See Figures 4-77 through 4-79.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Raise the hood.
3. Disconnect the negative (–) battery cable at the battery.
4. Disconnect the positive (+) battery cable at the battery.

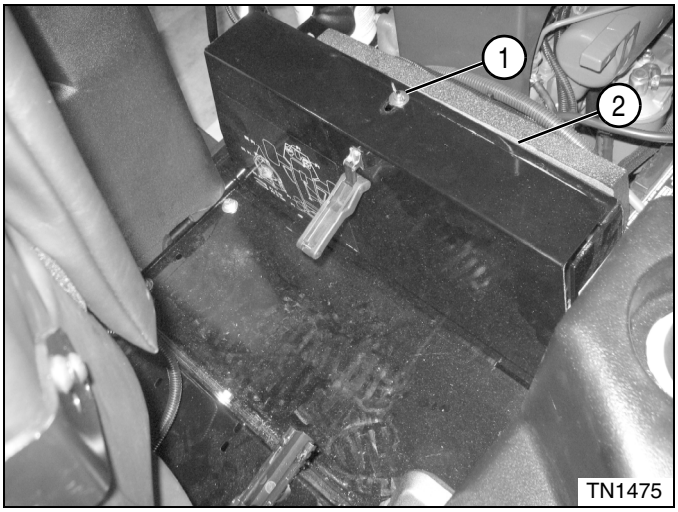

Figure 4-77

Move seat forward, loosen wing nut (1), and open control module cover (2).

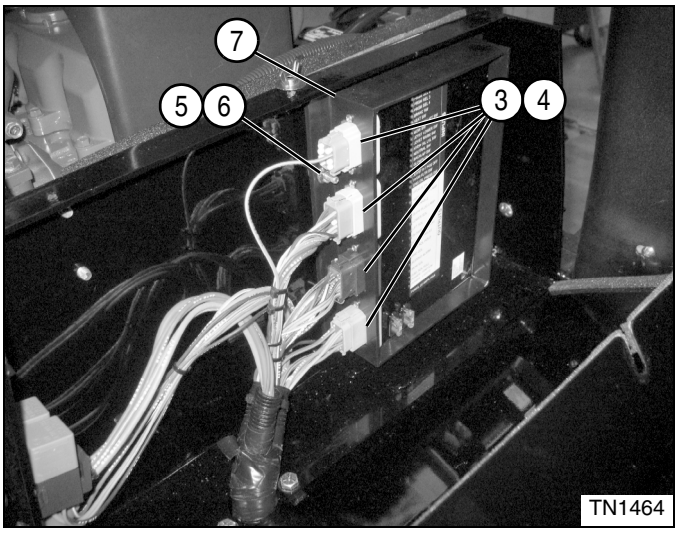

Figure 4-78

5. Disconnect the wiring harness connectors (3) from the control module sockets (4).
6. Remove mounting screws and nuts (5 and 6) from control module (7).

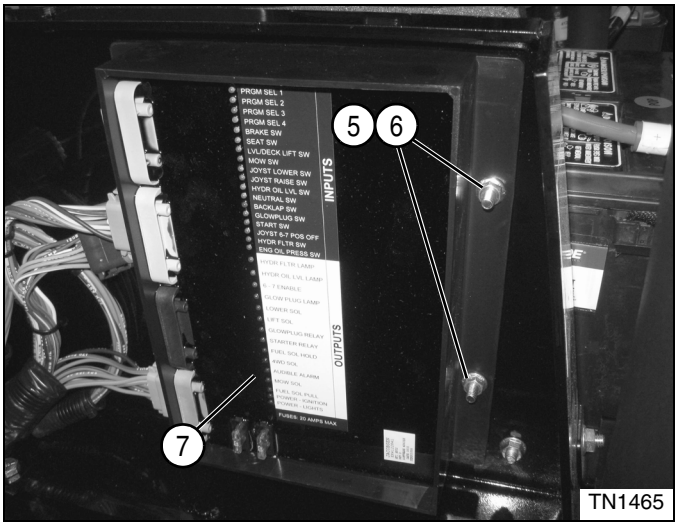

Figure 4-79

7. Remove mounting screws and nuts (5 and 6) from control module (7).
8. Remove the control module (7).

Installation Note

Install the control module by reversing the order of removal.

Fuel and Water Gauge

Removal and Installation

See Figures 4-80 and 4-81.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Disconnect the negative (–) battery cable at the battery.
3. Remove the instrument panel. (See “Instrument Panel” on page 4-71.)

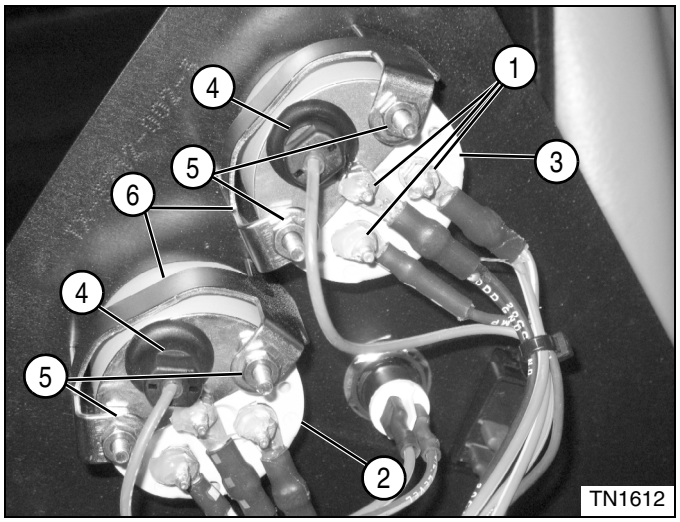

Figure 4-80

NOTE

Label all wires before disconnecting to ensure correct installation.

1. Remove three nuts (1), and disconnect the wires from the fuel gauge (2) and water gauge (3).
2. Remove indicator lights from gauge housing by pulling gently on the bulb socket (4).
3. Remove the two nuts (5) securing gauge brackets (6).

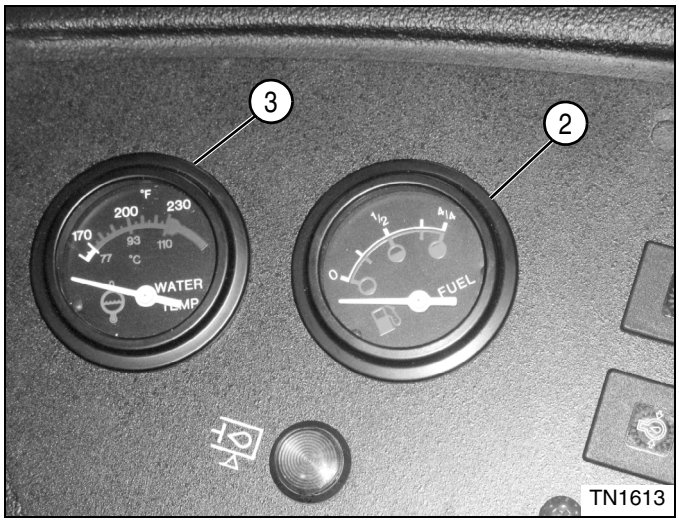

Figure 4-81

4. Lift gauges (2 and 3) straight up and out of the instrument panel.

Installation Note

Install the fuel and water temperature gauges by reversing the order of removal.

Fuel Level Sender

Removal and Installation

See Figure 4-82.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Disconnect the negative (–) battery cable at the battery.
3. Remove the instrument panel. (See “Instrument Panel” on page 4-71.)

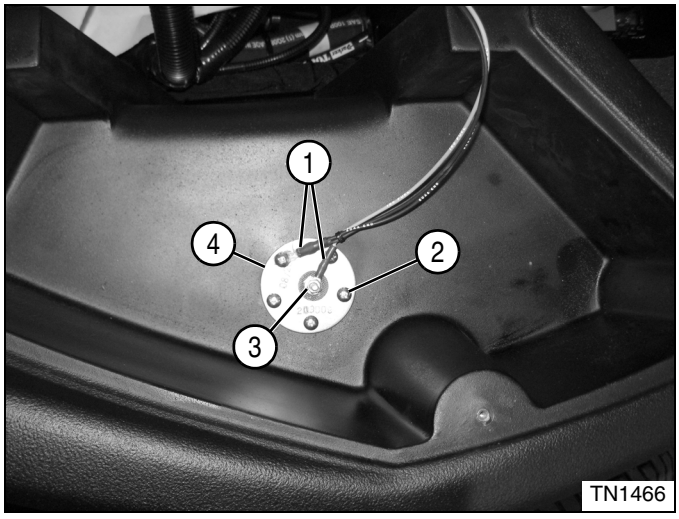

Figure 4-82

NOTE

Label all wires before disconnecting to ensure correct installation.

4. Remove nut (3), and disconnect wires (1) from fuel level sender (4).
5. Remove five screws (2).
6. Remove fuel level sender (4).

Installation Note

Install the fuel level sender by reversing the order of removal.

Horn

Removal and Installation

See Figure 4-83.

1. Park the mower safely.(See “Park Mower Safely” on page 1-5.)
2. Disconnect the battery negative (–) cable at the battery.
3. Remove the instrument panel. (See “Instrument Panel” on page 4-71.)

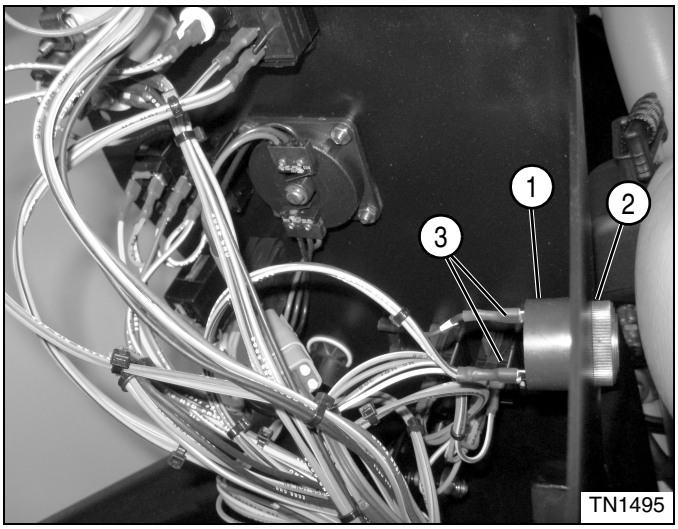

Figure 4-83

NOTE

Label all wires before disconnecting to ensure correct installation.

4. Disconnect wires (3) from horn (1).
5. Remove ring (2).
6. Remove horn (1).

Installation Note

Install the horn by reversing the order of removal.

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Chapter 5

Hydrostatic Power Train

5

JACOBSEN
A Textron Company

Specifications

Test and Adjustment Specification

Specification		
Traction Pump Flow	gpm (lpm)	35 (132)
Charge Pump Flow	gpm (lpm)	10.5 (40)
Forward System Relief Pressure	psi (bar)	3625 (250)
Reverse System Relief Pressure	psi (bar)	3625 (250)
Charge Pressure	psi (bar)	275—285 (19—20)
Hydrostatic Leakage Percentage Ranges		0—10% = Good 11—20% = Marginal 21% and Beyond = Bad

Repair Specifications

Specification		
Traction Pump—Servo Lock Nut Torque	lb-ft (N·m)	15 ± 3 (20 ± 4)
Traction Pump Weight	lb (kg)	131 (59)
Front Wheel Motor—Check Plug Torque	lb-ft (N·m)	8 ± 3 (10 ± 3)
Front Wheel Motor—Plug Torque	lb-ft (N·m)	13 (17)
Front Wheel Motor—Retainer Screw Torque	lb-ft (N·m)	25 (34)
Front Wheel Motor—Valve Housing Screw Torque	lb-ft (N·m)	63 (85)
Rear Wheel Motor—Valve Housing Screw Torque	lb-ft (N·m)	37 (50)
Rear Wheel Motor Hub Nut	lb-ft (N·m)	200 ± 25 (271 ± 34)
Front Wheel Motor Hub Nut	lb-ft (N·m)	400 ± 25 (542 ± 34)

Portable In-Line Filter

When hydraulic components fail internally, debris from the failed component can spread throughout the hydraulic system causing additional damage. Contaminated hydraulic systems should be filtered using a portable in-line filter available through your Jacobsen Dealer.

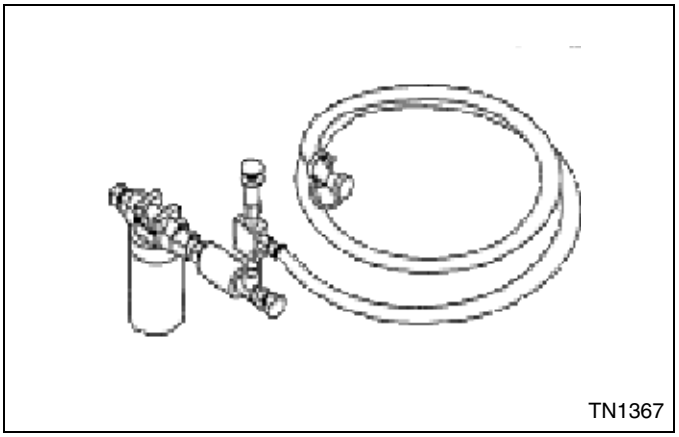
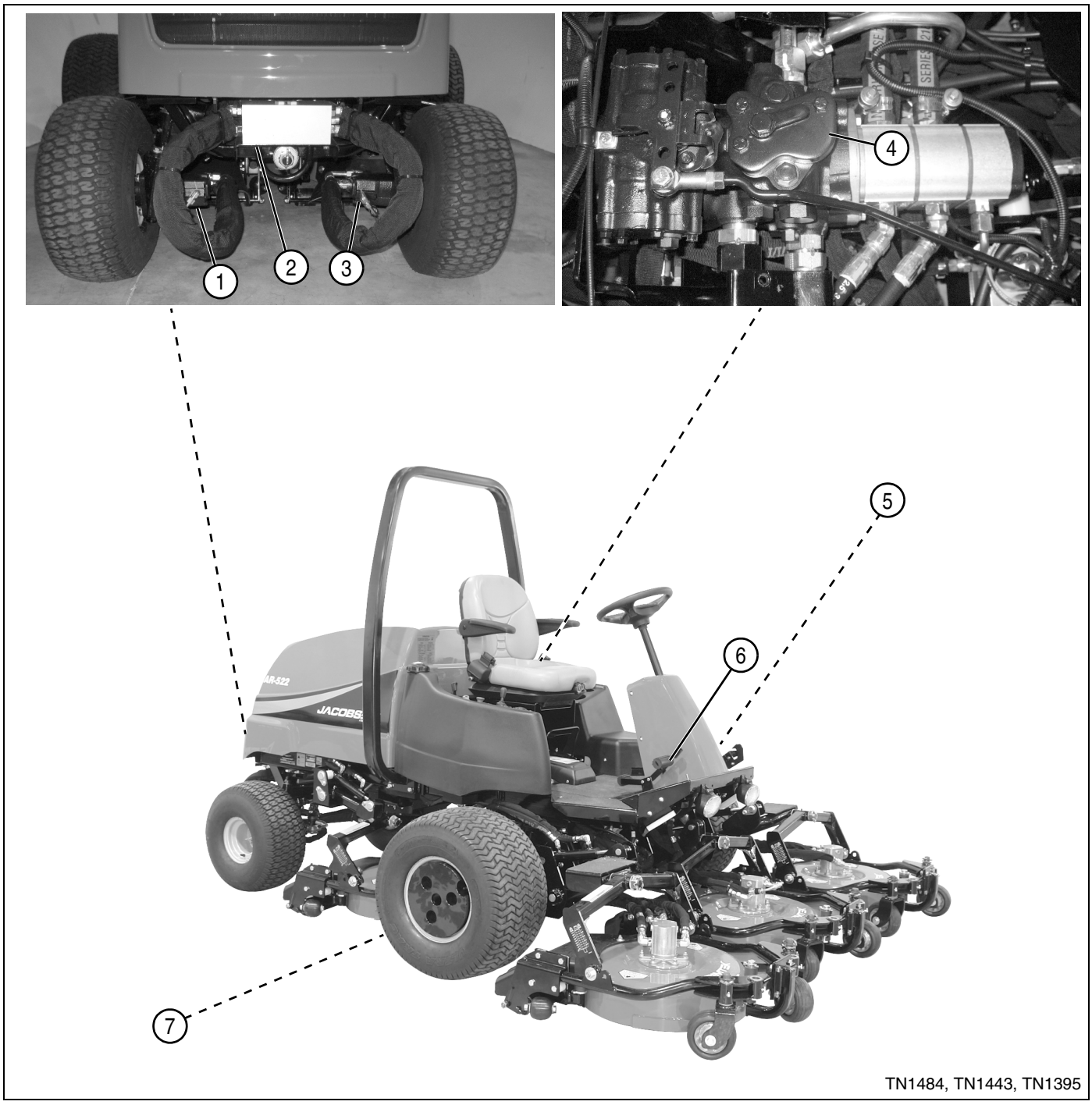


Figure 5-1

Component Location

See Figure 5-2.



1 Left Rear Wheel Motor
2 4WD Valve
3 Right Rear Wheel Motor
4 Hydrostatic Pump
5 Left Front Wheel Motor
6 Traction Pedal
7 Right Front Wheel Motor

Figure 5-2: Power Train Component Location

Theory of Operation and Sub-Circuit Schematics

Traction Circuit Forward Schematic and Theory of Operation

See Figure 5-3.

System Conditions:

- Engine running
- Park brake released
- Traction pedal depressed (forward position)

Charge Pressure Circuit

The charge pump and traction pump are both driven by the engine. The charge pump is mounted between the rotating group and rear valve plate assembly in the traction pump housing. It supplies oil to the traction pump/circuit. Oil is drawn from the hydraulic tank, through a 100 mesh screen, and enters the charge pump. Oil is then routed to the charge pressure relief valve, the traction pump, and the displacement control valve. The charge pressure relief valve regulates the charge pressure applied to the traction pump/circuit. When the incoming charge pressure oil reaches 285 psi (20 bar), the charge pressure relief valve will open, venting excess flow to the hydraulic tank.

Traction Pump Circuit

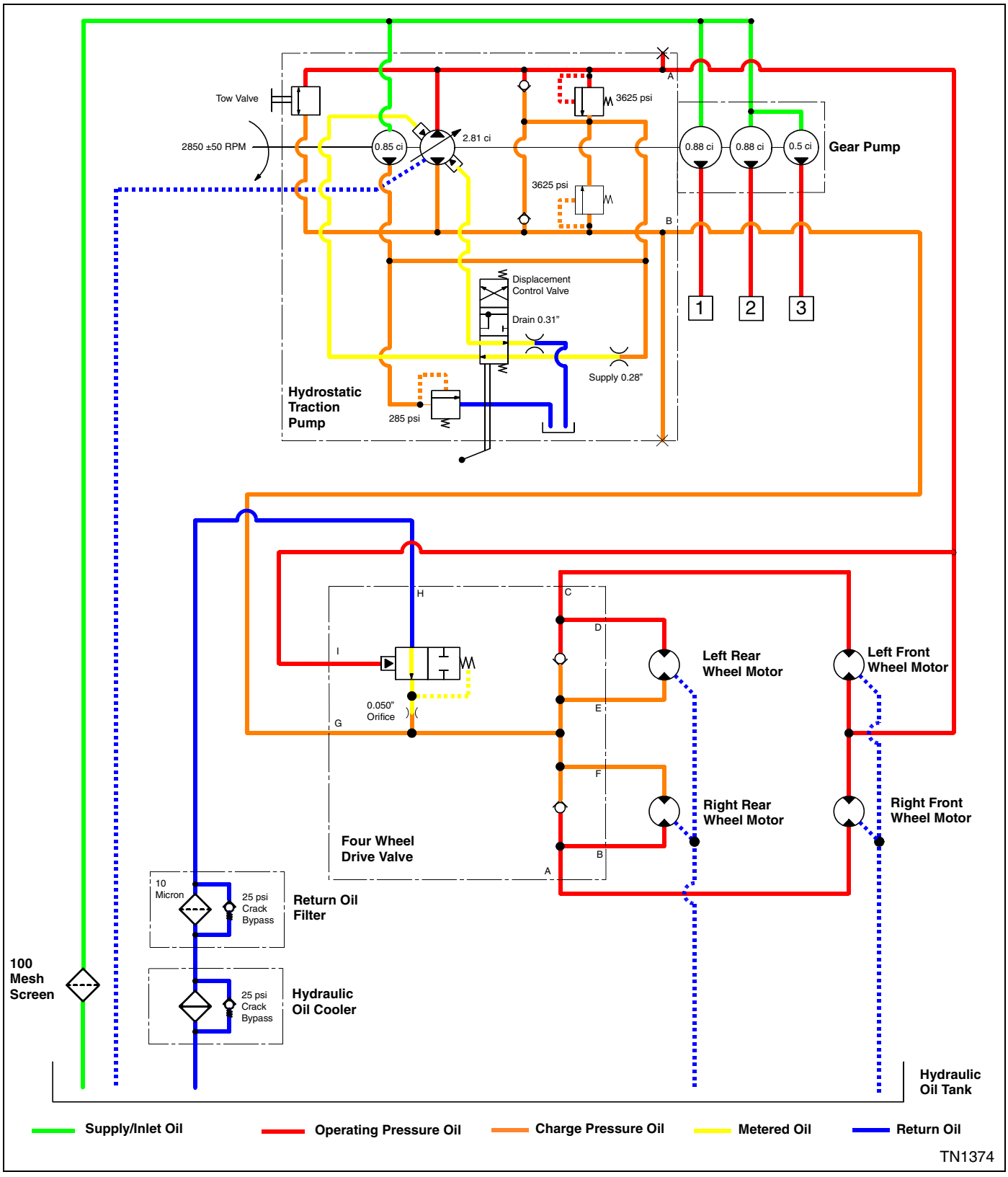
When the traction pedal is moved to the forward position, the displacement control valve is moved to the forward position. Charge oil is supplied through 0.28” orifice, displacement control valve, and to the traction pump, moving the swash plate, stroking the pump, and producing oil flow to port “A.” Operating pressure oil from port “A” of the traction pump is supplied in parallel to the front wheel motors and in series to the rear wheel motors, resulting in full-time four-wheel drive. Oil from the rear wheel motors returns to the traction pump, entering through port “B.” The 0.28” orifice meters the amount of oil to servo piston which dampens the flow of oil, reducing the chance of wheel spin. The 0.31” office dampens the flow of oil to tank. The traction circuit is protected by a circuit relief valve. This valve will open, venting excess oil flow to the return side of loop when the pressure rises above 3625 psi (250 bar).

Hot Oil Shuttle

The hot oil shuttle is located in the 4WD valve. The hot oil shuttle is held open when there is operating pressure oil in the forward direction. This allows a small amount of charge pressure oil to drain to the hydraulic tank for oil cooling.

Traction Circuit—Forward Schematic

See Figure 5-3.



1 Operating Pressure Oil to Deck Valve Port P2 2 Operating Pressure Oil to Deck Valve Port P1 3 Operating Pressure Oil to Steering Unit

Figure 5-3

Traction Circuit Reverse Schematic and Theory of Operation

See Figure 5-4.

System Conditions:

- Engine running
- Park brake released
- Traction pedal depressed (reverse position)

Charge Pressure Circuit

The charge pump and traction pump are both driven by the engine. The charge pump is mounted between the rotating group and rear valve plate assembly in the traction pump housing. It supplies oil to the traction pump/circuit. Oil is drawn from the hydraulic tank, through a 100 mesh screen, and enters the charge pump. Oil is then routed to the charge pressure relief valve, the traction pump, and the displacement control valve. The charge pressure relief valve regulates the charge pressure applied to the traction pump/circuit. When the incoming charge pressure oil reaches 285 psi (20 bar), the charge pressure relief valve will open, venting excess flow to the hydraulic tank.

Traction Pump Circuit

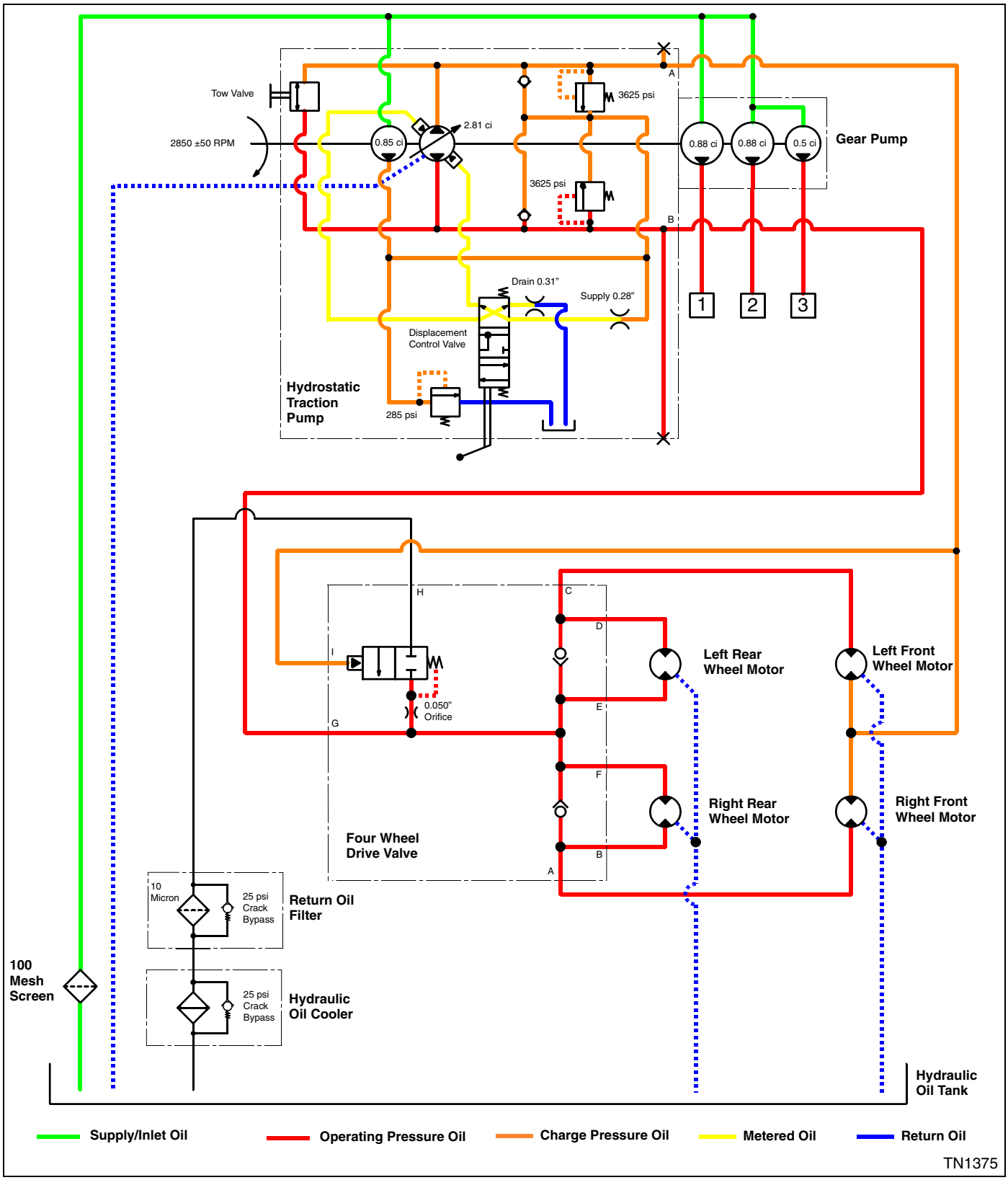
When the traction pedal is moved to the reverse position, the displacement control valve is moved to the reverse position. Charge oil is supplied through 0.28” orifice, displacement control valve, and to the traction pump, moving the swash plate, stroking the pump, and producing oil flow to port “B.” Operating pressure oil from port “B” of the traction pump is supplied in parallel to the rear wheel motors and in series to the front wheel motors. Oil from the rear wheel motors returns to the traction pump, entering through port “A.” The 0.28” orifice meters the amount of oil to servo piston which dampens the flow of oil, reducing the chance of wheel spin. The 0.31” orifice dampens the flow of oil to tank. The traction circuit is protected by a circuit relief valve. This valve will open, venting excess oil flow to the return side of loop. when the pressure rises above 3625 psi (250 bar).

Hot Oil Shuttle

The hot oil shuttle is located in the 4WD valve. The hot oil shuttle is held closed when there is operating pressure in the reverse direction.

Traction Circuit—Reverse Schematic

See Figure 5-4.



1 Operating Pressure Oil to Deck Valve Port P2 2 Operating Pressure Oil to Deck Valve Port P1 3 Operating Pressure Oil to Steering Unit

Figure 5-4

Troubleshooting

Symptom: Mower Will Not Move Forward or Reverse

Probable Cause	Remedy
Hydraulic oil not at correct level in reservoir.	Fill reservoir to correct level. (Refer to “Safety, Operation, and Maintenance Manual” for the correct oil specifications.)
Tow valve open.	Close tow valve.
Incorrect charge pressure relief setting.	Test charge pressure relief valve setting. (See “Charge Pressure Test” on page 5-15.)
Faulty charge pump.	Test and repair. (See “Charge Pressure Test” on page 5-15.)
Faulty wheel motor.	Test and repair. (See “Wheel Motors Test” on page 5-20.)
Faulty traction pump.	Test and repair. (See “Traction Pump Tests” on page 5-18.)

Symptom: Mower Will Not Reach Full Speed

Probable Cause	Remedy
Hydraulic oil not at correct level in reservoir.	Fill reservoir to correct level. (Refer to “Safety, Operation, and Maintenance Manual” for the correct oil specifications.)
Tow valve open.	Close tow valve.
Air bubbles in hydraulic oil.	Check suction line for air leaks.
Incorrect charge pressure relief setting.	Test charge pressure relief valve setting. (See “Charge Pressure Test” on page 5-15.)
Faulty charge pump.	Test and repair. (See “Charge Pressure Test” on page 5-15.)
Faulty traction pump.	Test and repair. (See “Traction Pump Tests” on page 5-18.)
Faulty wheel motor.	Test and repair. (See “Wheel Motors Test” on page 5-20.)

Symptom: Poor Hydrostatic Transmission Response

Probable Cause	Remedy
Hydraulic oil not at correct level in reservoir.	Fill reservoir to correct level. (Refer to “Safety, Operation, and Maintenance Manual” for the correct oil specifications.)
Tow valve open.	Close tow valve.
Incorrect charge pressure relief setting.	Test charge pressure relief valve setting. (See “Charge Pressure Test” on page 5-15.)
Faulty charge pump.	Test and repair. (See “Charge Pressure Test” on page 5-15.)
Faulty hydrostatic pump.	Test and repair. (See “Traction Pump Tests” on page 5-18.)

Symptom: Hydrostatic System Operating Hot

Probable Cause	Remedy
Hydraulic oil not at correct level in reservoir.	Fill reservoir to correct level. (Refer to “Safety, Operation, and Maintenance Manual” for the correct oil specifications.)
Tow valve open.	Close tow valve.
Faulty hot oil shuttle valve.	Inspect and repair. (See “4WD Valve” on page 5-32.)
Oil cooler has dirt or debris in fins.	Clean oil cooler fins of dirt and debris.
Incorrect charge pressure relief setting.	Test charge pressure relief valve setting. (See “Charge Pressure Test” on page 5-15.)
Faulty charge pump.	Test and repair. (See “Charge Pressure Test” on page 5-15.)
Faulty relief valve.	Test and repair. (See “Traction Pump Tests” on page 5-18.)

Symptom: Excessive Pump Noise

Probable Cause	Remedy
Hydraulic oil not at correct level in reservoir.	Fill reservoir to correct level. (Refer to “Safety, Operation, and Maintenance Manual” for the correct oil specifications.)
Hydraulic oil cold.	Warm hydraulic oil to operating temperature.
Pump damage.	Repair pump as necessary. (See “Traction Pump” on page 5-27.)

Tests and Adjustments

Transmission Neutral Adjustment

Adjust Transmission Neutral (Creep)

See Figures 5-5 and 5-7.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove the center floorboard.
3. Confirm tow valve is closed.
4. Bypass seat switch.

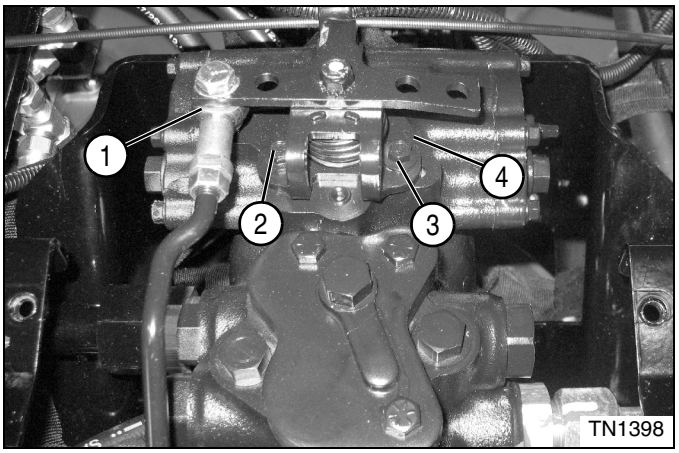


Figure 5-5

5. Disconnect traction pedal linkage (1) from traction pump.
6. Loosen screws (2 and 3).

WARNING

Prevent personal injury. Use properly rated lifting devices. Always be sure load is balanced before lifting.

Support the machine properly using jack stands.

IMPORTANT

It is important to lift and support the machine or the machine will move.

7. Lift the machine so that front and rear wheels are off the ground and support with stands.

WARNING

Never operate the engine without proper ventilation; exhaust fumes can be fatal if inhaled.

CAUTION

Engine component will become hot during operation. Use caution when working near engine components while performing service. Failure to follow safety recommendations may result in injury.

8. Start the engine, release brake, and observe the wheels.
9. Adjust bracket (5) until wheels do not turn.
10. Tighten screws (2 and 3) making sure wheels are not turning.
11. Stop the engine and apply brake.
12. Connect traction pedal linkage (1).
13. Adjust traction pedal neutral switch. (See “Adjust Traction Pedal Neutral Switch” on page 5-12.)
14. Start the engine and release brake.
15. Move the traction pedal to the forward and reverse positions and release the pedal. Pedal should return to the neutral position.

    When in the neutral position, there should be no wheel movement.
16. Stop the engine and apply brake.
17. Repeat the procedure if any wheel movement is noted.

NOTE

If after repeating the procedure and there is still wheel movement, the control sleeve may be sticking. Continue to step 18.

18. Disconnect traction pedal linkage (1) from the traction pump.
19. Remove screws (2 and 3).

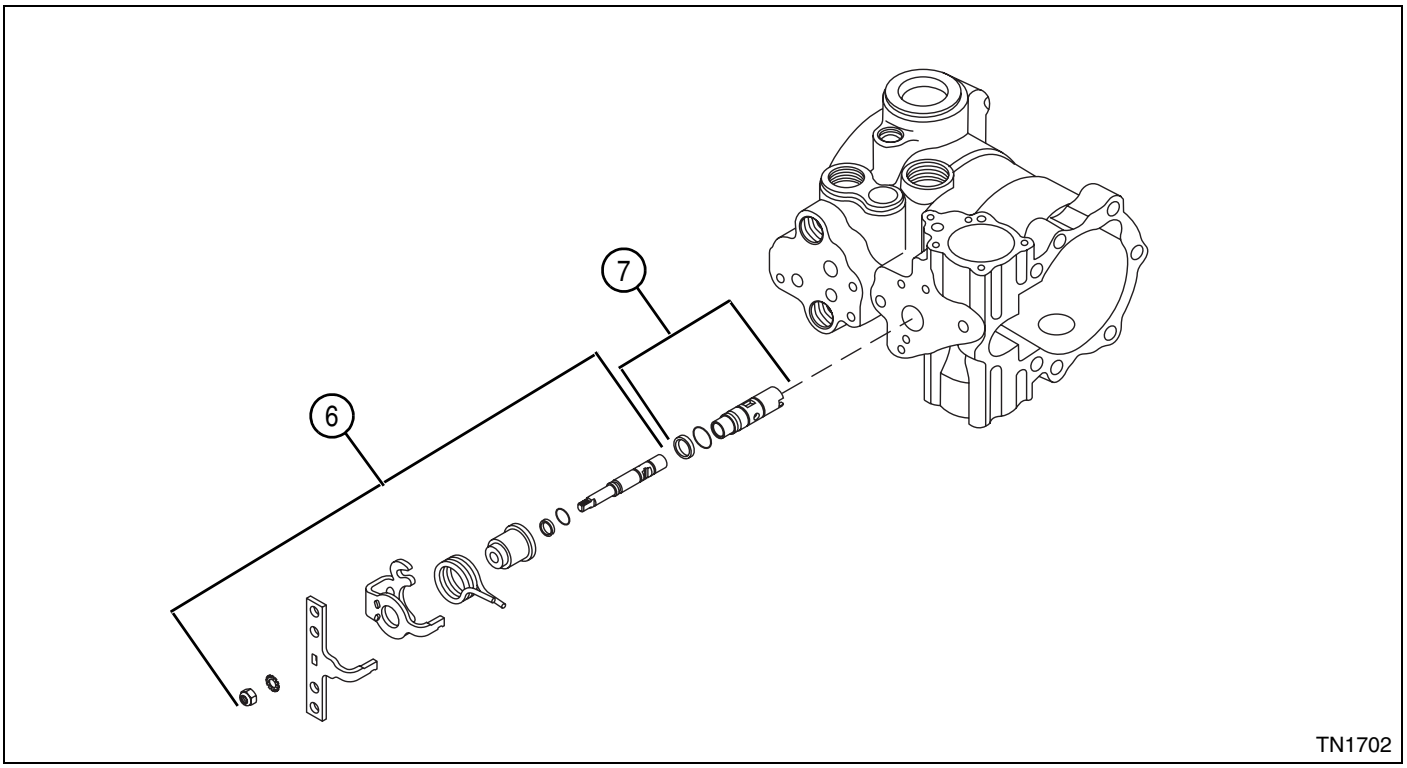


Figure 5-6

20. Remove control spool (6) as an assembly. Clean and inspect.

NOTE

Control sleeve (7) may be difficult to remove. If needed, use a blind race puller with a slide hammer to remove.

21. Remove control sleeve (7) as an assembly. Clean and inspect.
22. If needed, repair or replace control sleeve (7) and control spool (6).
23. Install control sleeve (7) as an assembly.
24. Install control spool (6) as an assembly.
25. Install screws (2 and 3) but do not tighten.

WARNING

Prevent personal injury. Use properly rated lifting devices. Always be sure load is balanced before lifting.

Support the machine properly using jack stands.

IMPORTANT

It is important to lift and support the machine or the machine will move.

26. Lift the machine so that front and rear wheels are off the ground and support with stands.

WARNING

Never operate the engine without proper ventilation; exhaust fumes can be fatal if inhaled.

CAUTION

Engine component will become hot during operation. Use caution when working near engine components while performing service. Failure to follow safety recommendations may result in injury.

27. Start the engine, release brake, and observe the wheels.
28. Adjust bracket (5) until wheels do not turn.
29. Tighten screws (2 and 3) making sure wheels are not turning.
30. Stop the engine and apply brake.
31. Connect traction pedal linkage (1).
32. Adjust traction pedal neutral switch. (See “Adjust Traction Pedal Neutral Switch” on page 5-12.)
33. Start the engine and release brake.

34. Move the traction pedal to the forward and reverse positions and release the pedal. Pedal should return to the neutral position.

    When in the neutral position, there should be no wheel movement.
35. Stop the engine and apply brake.
36. Repeat the procedure if any wheel movement is noted.
37. Install and connect all components as noted prior to adjustment.

Adjust Traction Pedal Neutral Switch

See Figure 5-7.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Allow the traction pedal to return to the neutral position.

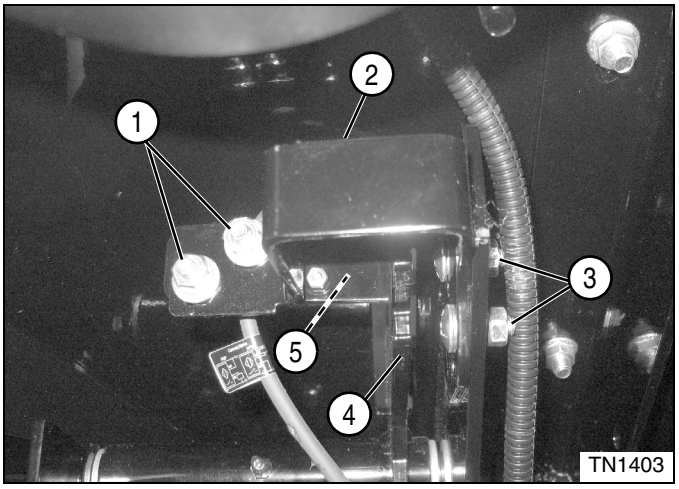


Figure 5-7

3. Align the proximity switch:

    To adjust the vertical alignment of the proximity switch: Loosen two screws (1) and center the proximity switch (5) with traction pedal pointer (4). Tighten the screws.

    To adjust the horizontal alignment of the proximity switch: Loosen two screws (3) and slide the proximity switch bracket (2) as needed, centering proximity switch (5) with traction pedal pointer (4). Tighten the screws.
4. Check the operation of the switch by depressing the traction pedal so that the proximity switch (5) is closed when the traction pedal is in neutral position and open when the traction pedal is moved out of neutral position. (See “Neutral Proximity Switch” on page 4-75.)

Field Test Procedures

When a hydraulic system failure occurs, some simple effective tests can be performed prior to using a test instrument. The results of these tests can lead you to the suspected component failure. More extensive test procedures, using test instruments, are presented later in this section. (See “Instrument Test Procedures” on page 5-14.)

Preliminary Checks

Perform the following checks prior to beginning any tests.

1. Check the hydraulic oil reservoir for proper fluid level, the presence of air or water, and unusual odor.
2. Check all lines and fittings for leaks. Tighten as needed.
3. Eliminate all mechanical issues prior to starting hydraulic tests.

Charge Pump Test

The charge pump supplies oil for charging the traction circuit and traction pump.

If faults exist in the charge pump, proceed with an instrument test for the charge pump. (See “Charge Pressure Test” on page 5-15.)

Traction System Test

See Figure 5-8.

NOTE

Be sure tow valve is closed before beginning traction system test.

1. Operate hydraulic system until oil temperature is at 120—150°F (49—65°C).

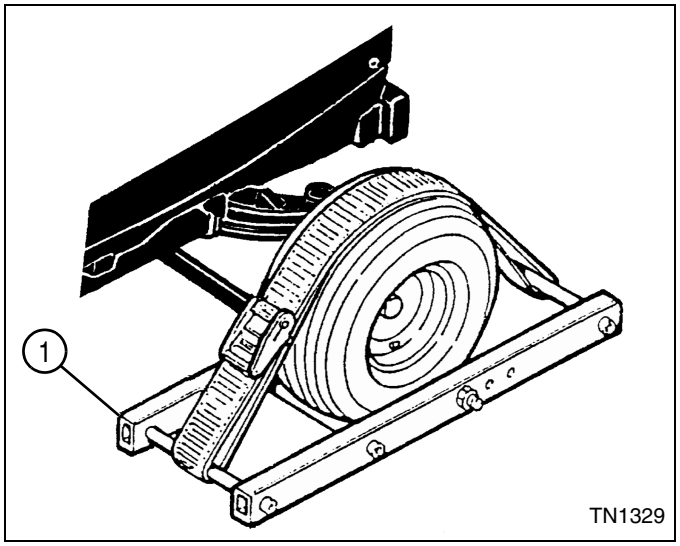


Figure 5-8

2. Install wheel restraints (1) to both front wheels.
3. Lift the machine so that rear wheels are off the ground and support with stands.
4. Lower the cutting units and move throttle lever to full throttle. Slowly push the traction pedal forward.

Does the engine labor or stall?

YES *The traction pump is not faulty.*

NO *A fault exists in the hydrostatic drive circuit, including the traction pump or wheel motors. Proceed to instrument test. (See "Instrument Test Procedures" on page 5-14.)*

Wheel Motor Test

The wheel motor case drain is used to return lubrication oil or bypassed hydraulic oil to the hydraulic tank.

1. Operate hydraulic system until oil temperature is at 120—150°F (49—65°C).
2. Stop the engine, apply brake, and remove the ignition key.
3. Remove the case drain hose from the wheel motor. Immediately plug the hose.
4. Position a drain pan with a minimum capacity of 1 gallon (3.8 L) near the wheel motor.
5. Install a separate hose on the case drain fitting and place the free end in the container. Secure the hose to prevent spills.

NOTES

- *When testing rear wheel motor, put wheel restraints on the rear wheels, lift front of machine so that front wheels are off the ground and support with jack stands.*
- *When testing front wheel motor, put wheel restraints on the front wheels, lift rear of machine so that rear wheels are off the ground and support with jack stands.*

6. Install wheel restraints. See Figure 5-8.
7. Lift and support the rear or front of the machine, depending on wheel being tested.
8. Start the engine, release brake, and place the traction pedal in the forward position for 15 seconds.
9. Stop the engine, apply brake, and remove the ignition key.
10. Measure the amount of oil collected from the case drain. Amount x 4 = amount per minute.

Is the oil measured less than 1 gallon per minute?

YES *The motor is not faulty. Proceed to instrument test. (See "Instrument Test Procedures" on page 5-14.)*

Is the oil measured more than 2 gallons per minute?

YES *The motor is faulty. Repair or replace as needed. (See "Front Wheel Motor" on page 5-34.) or (See "Rear Wheel Motor" on page 5-39.)*

Instrument Test Procedures

Instrument Test Overview

The following tests are specifically designed to approach hydraulic testing on a system level. Each component within the system represents a portion of the total system leakage. An internal leakage percentage for each component will be calculated and recorded, enabling the technician to view the system performance issue more completely. The test results will help the technician to decide which repairs will best remedy the performance issue experienced by the machine user.

The internal leakage percentage ranges are as follows:

0—10% = Good

11—20% = Marginal

21% and beyond = Bad

Example: Traction System Performance Complaint

The machine operator reports the machine struggles to climb hills.

A charge pressure test must first be performed to rule out a charge pump issue. Next, the entire traction system is tested as outlined, and the calculated system leakage is 37%; a result which requires the testing of individual components. This result can also be interpreted as the system is 63% efficient.

The remaining components in question are as follows: traction pump, left front wheel motor, left check valve, left rear wheel motor, right front wheel motor, right check valve, and right rear wheel motor. Following the procedures as outlined, test each individual component, then calculate and record leakage percentages.

The results from this test reveal leakage of 3.3% in the traction pump, 20% in the left front wheel motor, 1.7% in the left check valve, 1.8% in the left rear wheel motor, 2.1% in the right front wheel motor, 2.8% in the right check valve, and 4.3% in the right rear wheel motor. Although all the components lend to the overall system leakage, only the left front wheel motor, which is at the extreme end of the marginal range, would be considered for repair/replacement.

Formulas:

Wheel Motor

Loaded Flow from previous component – Loaded Flow from current component / Loaded Flow from previous component x 100 = Leak Percentage

System and Traction Pump

No Load Flow – Loaded Flow / No Load Flow x 100 = Leak Percentage

Calculations:

System Test

No Load Flow = 15 gpm

Loaded Flow = 9.4 gpm

15 – 9.4 / 10 x 100 = Total System Leakage 37%

Traction Pump Test

No Load Flow = 15 gpm

Loaded Flow = 14.5 gpm

15 – 14.5 / 10 x 100 = Traction Pump Leakage 3.3%

Left Front Wheel Motor Test

Loaded Flow from traction pump test = 14.5 gpm

Loaded Flow from left front wheel motor test = 11.6 gpm

14.5 – 11.6 / 14.5 x 100 = Left Front Wheel Motor Leakage 20%

Left Check Valve Test

Loaded Flow from left front wheel motor test = 11.6 gpm

Loaded Flow from left check valve test = 11.4 gpm

11.6 – 11.4 / 11.6 x 100 = Left Check Valve Leakage 1.7%

Left Rear Wheel Motor Test

Loaded Flow from left check valve test = 11.4 gpm

Loaded Flow from left rear wheel motor test = 11.2 gpm

11.4 – 11.2 / 11.4 x 100 = Left Rear Wheel Motor Leakage 1.8%

Right Front Wheel Motor Test

Loaded Flow from traction pump test = 14.5 gpm

Loaded Flow from right front wheel motor test = 14.2 gpm

14.5 – 14.2 / 14.5 x 100 = Right Front Wheel Motor Leakage 2.1%

Right Check Valve Test

Loaded Flow from right front wheel motor test = 14.2 gpm

Loaded Flow from right check valve test = 13.8 gpm

14.2 – 13.8 / 14.2 x 100 = Right Check Valve Leakage 2.8%

Right Rear Wheel Motor Test

Loaded Flow from right check valve test = 13.8 gpm

Loaded Flow from right rear wheel motor test = 13.2 gpm

13.8 – 13.2 / 13.8 x 100 = Right Rear Wheel Motor Leakage = 4.3%

Charge Pressure Test

See Figures 5-9 and 5-10.

WARNING

The hydraulic system is under pressure, and the oil will be hot.

- **Always relieve pressure in the hydraulic system before performing service.**
- **Failure to follow appropriate safety precautions may result in death or serious injury.**

Required Tools and Materials
• Pressure Gauge 500 psi (35 bar) • Test Hose 500 psi (35 bar) • -6 ORB Adapter

1. Operate hydraulic system until oil temperature is at 120—150°F (49—65°C).
2. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
3. Remove the center floorboard.

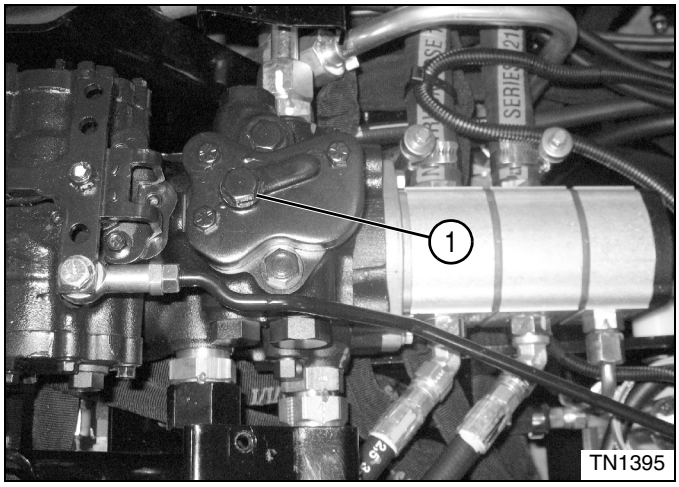


Figure 5-9

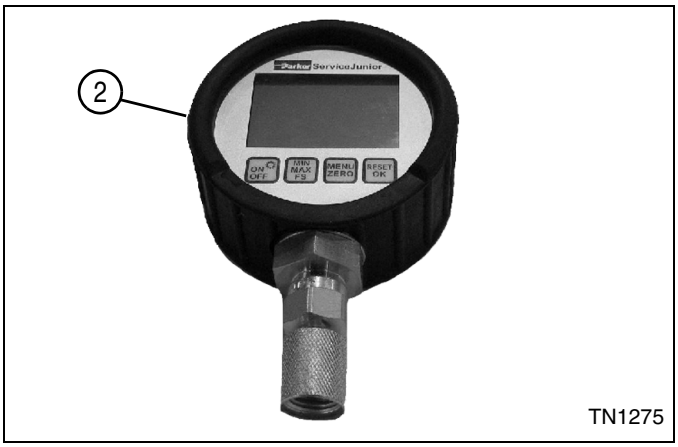


Figure 5-10

4. Connect adapter, test hose, and pressure gauge (2) to port (1).

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

5. Start engine and run at full throttle (2850 rpm ± 50).
6. Record pressure reading.
7. Stop the engine.

   Is charge pressure 275–285 psi (19–20 bar)?

   YES *Charge pressure relief valve is good. Proceed to step 8.*

   NO *Replace charge pressure relief valve. (See “Traction Pump” on page 5-27.)*
8. Disconnect and remove test equipment. Install all hoses and fittings as noted prior to removal.
9. Install and connect all components as noted prior to test.
10. Check hydraulic oil level. Add oil as needed. (Refer to “Safety, Operation, and Maintenance Manual” for correct oil specifications.)

Traction System Test

See Figures 5-11 through 5-14.

IMPORTANT

- **This test works together with the wheel motors test to isolate a problem within the hydrostatic power train.**
- **Performing this test will isolate the traction pump and front wheel motors from the rest of the hydrostatic system.**

WARNING

The hydraulic system is under pressure, and the oil will be hot.

- **Always relieve pressure in the hydraulic system before performing service.**
- **Failure to follow appropriate safety precautions may result in death or serious injury.**

Required Tools and Materials
• Flow Meter • -12 ORFS Test Hose 4000 psi (276 bar) • Flow Lock Tool

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove the center floorboard and seat.
3. Bypass seat switch.

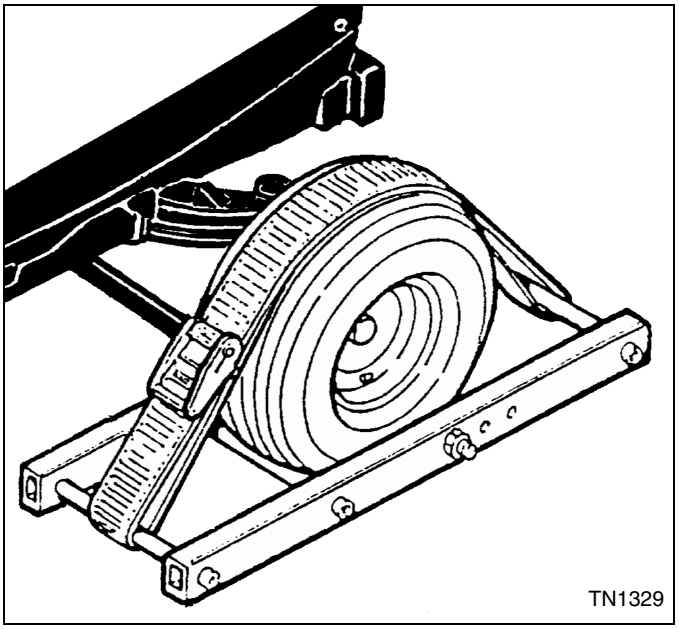


Figure 5-11

4. Install wheel restraints to front wheels.

WARNING

Prevent personal injury. Use properly rated lifting devices. Always be sure load is balanced before lifting.

Support the machine properly using jack stands.

IMPORTANT

It is important to lift and support the rear of machine or the machine will move.

5. Lift and support the machine so that the rear wheels are off the ground.
6. Disconnect traction pump control rod from pump control arm.

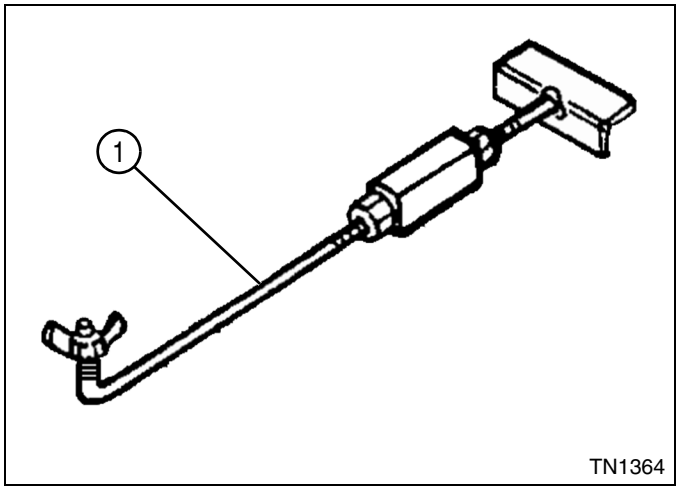


Figure 5-12

7. Install flow lock tool (1) and secure to pump control arm.
8. Close tow valve completely by turning clockwise.

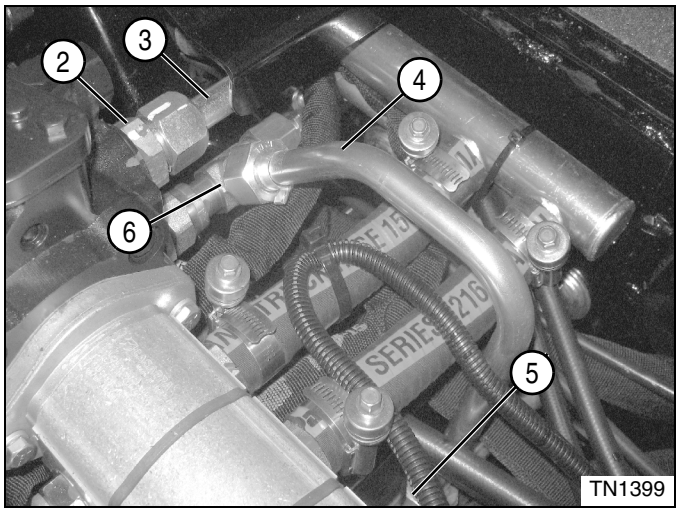


Figure 5-13

9. Remove drive tube (4).
10. Disconnect hose (3).

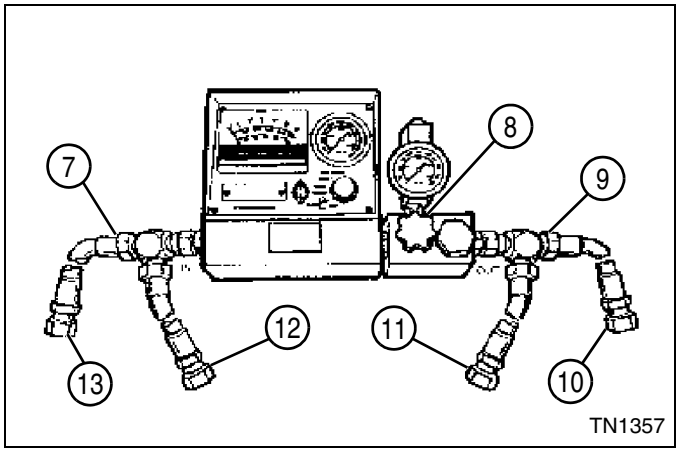


Figure 5-14

11. Connect test hose (13) of flow meter inlet to fitting (5).
12. Connect test hose (12) of flow meter inlet to fitting (6).
13. Connect hose (10) of flow meter outlet to hose (3).
14. Connect test hose (11) of flow meter outlet to fitting (2).
15. Open flow meter valve (8) completely before starting engine.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

16. Start engine, release brake, and run at full throttle (2850 rpm ± 50).
17. Adjust flow lock tool (1) to allow pump to produce 15 gpm (57 lpm) in the forward direction.
18. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve (8) until a reading of 1800 psi (124 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.
19. After warming the hydraulic oil, verify flow lock tool is adjusted to allow pump to produce 15 gpm (57 lpm) in the forward direction.
20. Read and record no load flow.
21. Slowly close flow meter valve (8) until pressure reaches 2700 psi (186 bar). Read and record loaded flow.
22. Stop engine, apply brake, and return flow lock tool back to neutral position.
23. Calculate traction system leakage.
(Step 20 – Step 21 / Step 20 x 100 = Leakage Percentage)

Is traction system leakage 10% or less?

YES *The traction system is good. Additional testing is required. Proceed to "Wheel Motors Test" on page 5-20.*

NO *Proceed to next question.*

Is traction system leakage 11% to 20%?

YES *The traction system is marginal. Additional testing is required.*

NO *Proceed to next question.*

Is traction system leakage 21% or more?

YES *Test individual components in traction system for leakage.*

24. Disconnect and remove test equipment. Install all hoses and fittings as noted prior to removal.
25. Install and connect all components as noted prior to test.
26. Check hydraulic oil level. Add oil as needed. (Refer to "Safety, Operation, and Maintenance Manual" for oil specifications.)

Traction Pump Tests

See Figures 5-15 and 5-16.

WARNING

The hydraulic system is under pressure, and the oil will be hot.

- **Always relieve pressure in the hydraulic system before performing service.**
- **Failure to follow appropriate safety precautions may result in death or serious injury.**

Required Tools and Materials
• Flow Meter • -12 ORFS Test Hose 4000 psi (276 bar) • -12 ORFS Blocking Disks • Flow Lock Tool

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Before performing this test, perform traction system test leaving flow meter and flow lock tool connected as outlined. (See “Traction System Test” on page 5-16.)

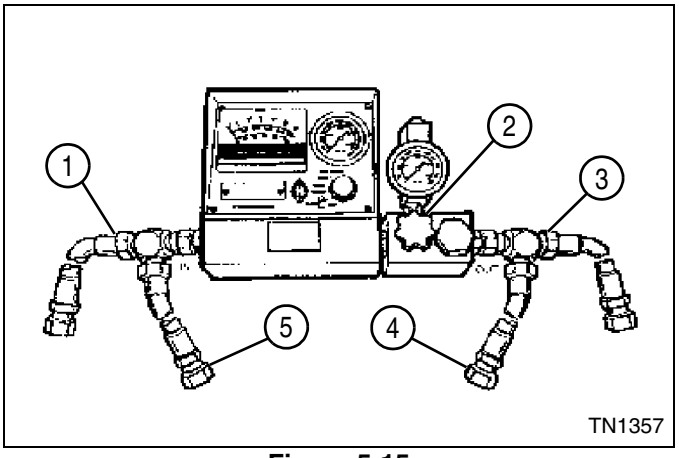


Figure 5-15

3. Install blocking disks at locations (1 and 3).
4. Open flow meter valve (2) completely before starting engine.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

5. Start engine, release brake, and run at full throttle (2850 rpm ± 50).

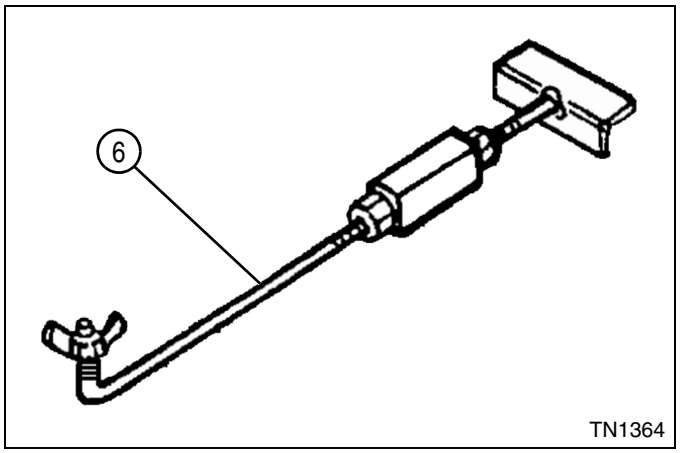


Figure 5-16

6. Adjust flow lock tool (6) to allow pump to produce 15 gpm (57 lpm) in the forward direction.
7. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve (2) until a reading of 1800 psi (124 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.
8. After warming the hydraulic oil, verify flow lock tool is adjusted to allow pump to produce 15 gpm (57 lpm) in the forward direction.
9. Read and record no load flow.
10. Slowly close flow meter valve (2) until pressure reaches 2700 psi (186 bar). Read and record loaded flow.
11. Stop engine, apply brake, and return flow lock tool back to neutral position.
12. Calculate traction pump leakage.
    (Step 9 – Step 10 / Step 9 x 100 = Leak Percentage)

    Is traction pump leakage 10% or less?

    YES *The traction pump is good. Proceed to step 17.*

    NO *Proceed to next question.*

    Is traction pump leakage 11% to 20%?

    YES *The traction pump is marginal. Additional testing is required. Continue to step 13.*

    NO *Proceed to next question.*

    Is traction pump leakage 21% or more?

    YES *Repair or replace traction pump. (See “Traction Pump” on page 5-27.)*

CAUTION

Do not exceed 3650 psi (252 bar) when testing system relief valves or equipment damage may occur.

13. Open flow meter valve (2) completely before starting engine.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

14. Start engine, release brake, and run at full throttle (2850 rpm ± 50).
15. Adjust flow lock tool (6) to allow pump to produce 15 gpm (57 lpm) in the forward direction.
16. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve (2) until a reading of 1800 psi (124 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C).
17. Continue to close flow meter valve (2) until zero flow is obtained. Record forward system relief valve pressure.
18. Stop engine, apply brake, and return flow lock tool back to neutral position.

NOTE

Reverse system relief valve test is similar.

19. To test reverse system relief valve, swap hoses (4 and 5) at flow meter.
20. Open flow meter valve (2) completely before starting engine.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

21. Start engine, release brake, and run at full throttle (2850 rpm ± 50).
22. Adjust flow lock tool to 15 gpm (57 lpm) in reverse direction.
23. Close flow meter valve (2) until zero flow is obtained and record reverse system relief valve pressure.
24. Stop engine, apply brake, and return flow lock tool back to neutral position.

    Is forward system relief pressure 3625 psi (250 bar)?

    YES *Forward system relief valve is good. Proceed to step 25.*

    NO *Replace forward system relief valve. (See “Traction Pump” on page 5-27.)*

    Is reverse system relief pressure 3625 psi (250 bar)?

    YES *Reverse system relief valve is good. Proceed to step 25.*

    NO *Replace reverse system relief valve. (See “Traction Pump” on page 5-27.)*
25. If no further testing is required, disconnect and remove test equipment. Install all hoses and fittings as noted prior to removal.
26. Install and connect all components as noted prior to test.
27. Check hydraulic oil level. Add oil as needed. (Refer to “Safety, Operation, and Maintenance Manual” for oil specifications.)

Wheel Motors Test

See Figures 5-17 through 5-22.

IMPORTANT

- **This test works together with the traction system test to isolate a problem within the hydrostatic power train.**
- **Performing this test will isolate the wheel motors and 4wd valve from the rest of the hydrostatic system. It will also isolate the system into right and left circuits.**

WARNING

The hydraulic system is under pressure, and the oil will be hot.

- **Always relieve pressure in the hydraulic system before performing service.**
- **Failure to follow appropriate safety precautions may result in death or serious injury.**

Required Tools and Materials
• Flow Meter
• -12 ORFS Test Hose 4000 psi (276 bar)
• -12 ORFS and -10 ORFS Blocking Disks
• Flow Lock Tool
• Wheel Restraints

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Before performing this test, perform traction system test leaving flow meter and flow lock tool connected as outlined. (See “Traction System Test” on page 5-16.)
3. (See Figure 5-15.) Remove the blocking disks from locations (1 and 3).
4. Connect hoses back to flow meter as outlined in traction system test. (See “Traction System Test” on page 5-16.)

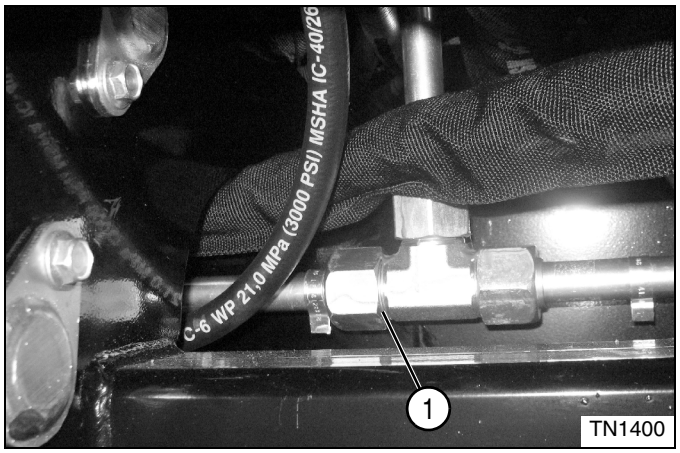


Figure 5-17

5. Install blocking disk at location (1), in front of front axle, to block oil from right wheel motor.

IMPORTANT

- **If performing this test after performing the traction system test, and the test results have proven the traction system to be good, proceed to step 16.**
- **If performing this test to determine which component in system is at fault (front wheel motor, check valve, or rear wheel motor) continue to step 6.**

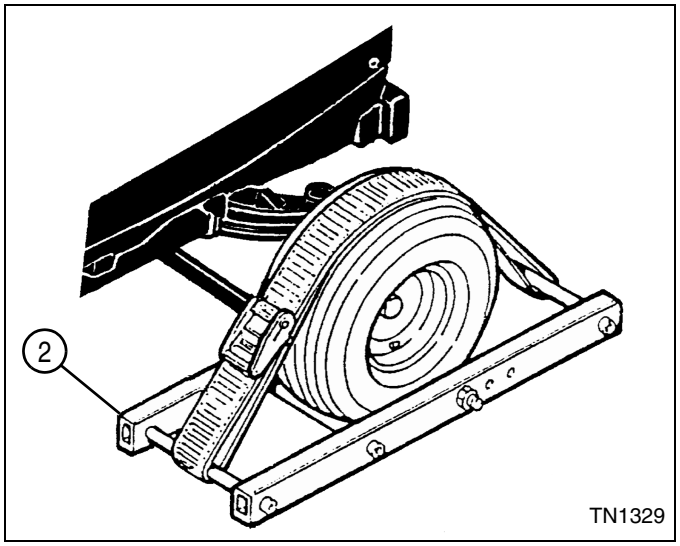


Figure 5-18

6. Install wheel restraint (2) to left front wheel.

WARNING

Prevent personal injury. Use properly rated lifting devices. Always be sure load is balanced before lifting.

Support the machine properly using jack stands.

IMPORTANT

It is important to lift the rear of machine and support with stands because if there is any leakage in the front wheel motor the machine will move.

7. Lift rear of machine and support with stands.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

8. Start engine, release brake, and run at full throttle (2850 rpm ± 50).

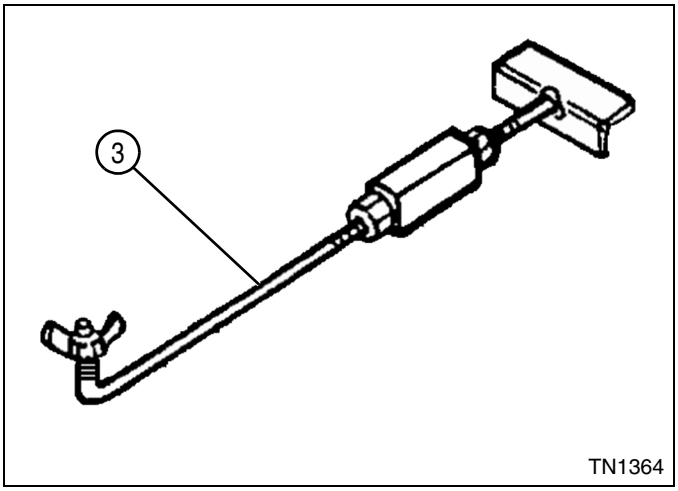


Figure 5-19

9. Adjust flow lock tool (3) to allow pump to produce 15 gpm (57 lpm) in the forward direction.
10. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve until a reading of 1800 psi (124 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.
11. After warming the hydraulic oil, verify flow lock tool is adjusted to allow pump to produce 15 gpm (57 lpm) in the forward direction.
12. Slowly close flow meter valve until pressure reaches 2700 psi (186 bar). Read and record loaded flow.
13. Stop engine, apply brake, and return flow lock tool back to neutral position.
14. Calculate left front wheel motor leakage. (Step 10 of previous test – Step 12 / Step 10 of previous test x 100 = Leak Percentage)

    Is left front wheel motor leakage 10% or less?

    YES *The left front wheel motor is good. Proceed to step 15.*

    NO *Proceed to next question.*

    Is left front wheel motor leakage 11% to 20%?

    YES *The left front wheel motor is marginal. Additional testing is required. Continue to step 15.*

    NO *Proceed to next question.*

    Is left front wheel motor leakage 21% or more?

    YES *Repair or replace left front wheel motor. (See "Front Wheel Motor" on page 5-34.)*
15. Remove wheel restraint from left front wheel.

WARNING

Prevent personal injury. Use properly rated lifting devices. Always be sure load is balanced before lifting.

Support the machine properly using jack stands.

IMPORTANT

It is important to lift and support the front of machine or the machine will move.

16. Lift the front of machine and support with stands.

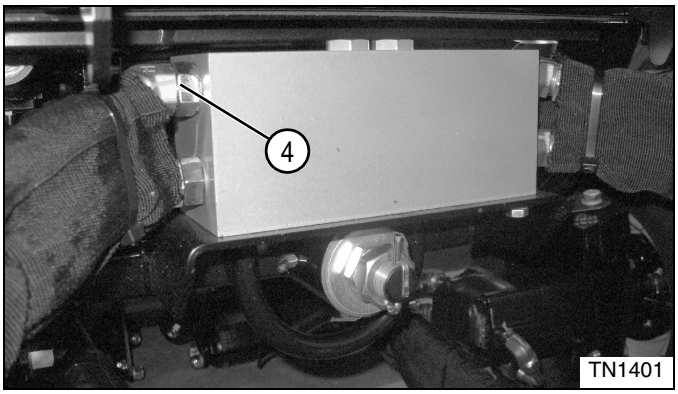


Figure 5-20

17. Install blocking disk at location (4) of 4WD valve.
18. Open flow meter valve completely before starting engine.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

19. Start engine, release brake, and run at full throttle (2850 rpm ± 50).
20. Adjust flow lock tool (3) to allow pump to produce 15 gpm (57 lpm) in the forward direction.
21. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve until a reading of 1800 psi (124 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.
22. After warming the hydraulic oil, verify flow lock tool is adjusted to allow pump to produce 15 gpm (57 lpm) in the forward direction.
23. Slowly close flow meter valve until pressure reaches 2700 psi (186 bar). Read and record loaded flow.
24. Stop engine, apply brake, and return flow lock tool back to neutral position.
25. Calculate left check valve leakage.
(Step 12 – Step 23 / Step 12 x 100 = Leak Percentage)

Is left check valve leakage 10% or less?

YES *The left check valve is good. Proceed to Step 26.*

NO *Proceed to next question.*

Is left check valve leakage 11% to 20%?

YES *The left check valve is marginal. Additional testing is required. Continue to step 26.*

NO *Proceed to next question.*

Is left check valve leakage 21% or more?

YES *Repair or replace left check valve. (See "4WD Valve" on page 5-32.)*

26. Remove blocking disk from location (4) of 4WD valve.
27. Install wheel restraint to left rear wheel.
28. Open flow meter valve completely before starting engine.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

29. Start engine, release brake, and run at full throttle (2850 rpm ± 50).
30. Adjust flow lock tool (3) to allow pump to produce 15 gpm (57 lpm) in the forward direction.
31. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve until a reading of 1800 psi (124 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.
32. After warming the hydraulic oil, verify flow lock tool is adjusted to allow pump to produce 15 gpm (57 lpm) in the forward direction.
33. Slowly close flow meter valve until pressure reaches 2700 psi (186 bar). Read and record loaded flow.
34. Stop engine, apply brake, and return flow lock tool back to neutral position.
35. Calculate left rear wheel motor leakage.
(Step 23 – Step 33 / Step 23 x 100 = Leak Percentage)

Is left rear wheel motor leakage 10% or less?

YES *The left rear wheel motor is good. Proceed to step 36.*

NO *Proceed to next question.*

Is left rear wheel motor leakage 11% to 20%?

YES *The left rear wheel motor is marginal. Additional testing is required. Continue to step 36.*

NO *Proceed to next question.*

Is left rear wheel motor leakage 21% or more?

YES *Repair or replace left rear wheel motor. (See "Rear Wheel Motor" on page 5-39.)*

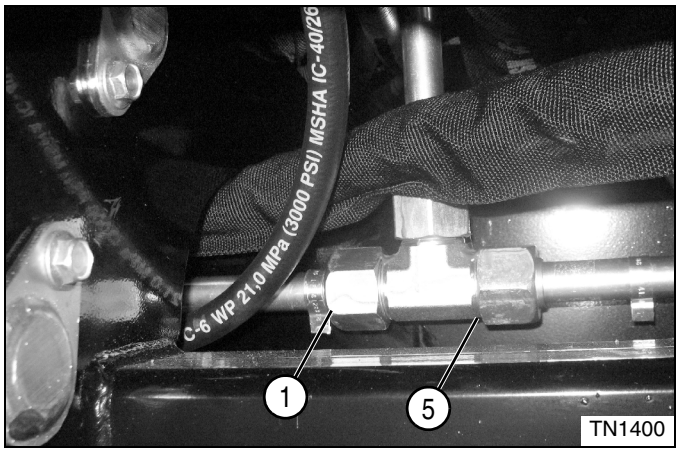


Figure 5-21

36. Remove blocking disk from location (1).
37. Install blocking disk at location (5), in front of front axle, to block oil from left wheel motor.

IMPORTANT

- **If performing this test after performing the traction system test, and the test results have proven the traction system to be good, proceed to step 49.**
- **If performing this test to determine which component in system is at fault (front wheel motor, check valve, or rear wheel motor) continue to step 38.**

38. Install wheel restraint to right front wheel.

WARNING

Prevent personal injury. Use properly rated lifting devices. Always be sure load is balanced before lifting.

Support the machine properly using jack stands.

IMPORTANT

It is important to lift the rear of machine and support with stands because if there is any leakage in the rear wheel motor the machine will move.

39. Lift rear of machine and support with stands.
40. Open flow meter valve completely before starting engine.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

41. Start engine, release brake, and run at full throttle (2850 rpm ± 50).
42. Adjust flow lock tool (3) to allow pump to produce 15 gpm (57 lpm) in the forward direction.
43. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve until a reading of 1800 psi (124 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.
44. After warming the hydraulic oil, verify flow lock tool is adjusted to allow pump to produce 15 gpm (57 lpm) in the forward direction.
45. Slowly close flow meter valve until pressure reaches 2700 psi (186 bar). Read and record loaded flow.
46. Stop engine, apply brake, and return flow lock tool back to neutral position.
47. Calculate right front wheel motor leakage. (Step 10 of traction pump test on page 5-18 – Step 45 / Step 10 of traction pump test on page 5-18 x 100 = Leak Percentage)

    Is right front wheel motor leakage 10% or less?

    YES *The right front wheel motor is good. Proceed to step 48.*

    NO *Proceed to next question.*

    Is right front wheel motor leakage 11% to 20%?

    YES *The right front wheel motor is marginal. Additional testing is required. Continue to step 48.*

    NO *Proceed to next question.*

    Is right front wheel motor leakage 21% or more?

    YES *Repair or replace right front wheel motor. (See "Front Wheel Motor" on page 5-34.)*
48. Remove wheel restraint from right front wheel.

WARNING

Prevent personal injury. Use properly rated lifting devices. Always be sure load is balanced before lifting.

Support the machine properly using jack stands.

IMPORTANT

It is important to lift and support the front of machine or the machine will move.

49. Lift front of machine and support with stands.

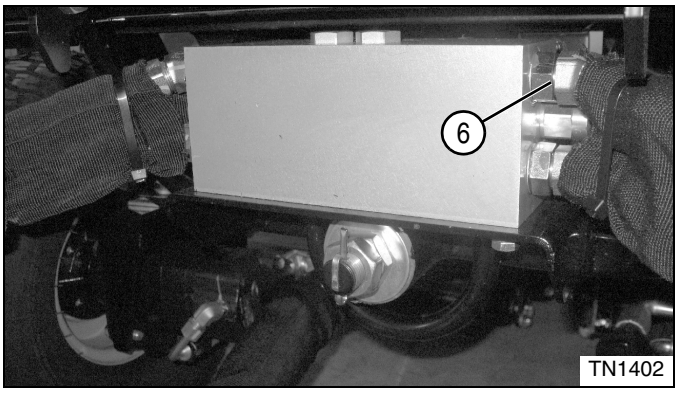


Figure 5-22

50. Install blocking disk at location (6) of 4WD valve.
51. Open flow meter valve completely before starting engine.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

52. Start engine, release brake, and run at full throttle (2850 rpm ± 50).
53. Adjust flow lock tool (3) to allow pump to produce 15 gpm (57 lpm) in the forward direction.
54. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve until a reading of 1800 psi (124 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.
55. After warming the hydraulic oil, verify flow lock tool is adjusted to allow pump to produce 15 gpm (57 lpm) in the forward direction.
56. Slowly close flow meter valve until pressure reaches 2700 psi (186 bar). Read and record loaded flow.
57. Stop engine, apply brake, and return flow lock tool back to neutral position.
58. Calculate right check valve leakage. (Step 45 – Step 56 / Step 45 x 100 = Leak Percentage)

    Is right check valve leakage 10% or less?

    YES *The right check valve is good. Proceed to Step 59.*

    NO *Proceed to next question.*

    Is right check valve leakage 11% to 20%?

    YES *The right check valve is marginal. Additional testing is required. Continue to step 59.*

    NO *Proceed to next question.*

    Is right check valve leakage 21% or more?

    YES *Repair or replace right check valve. (See "4WD Valve" on page 5-32.)*
59. Remove blocking disk from location (6) of 4WD valve.
60. Install wheel restraint to right rear wheel.
61. Open flow meter valve completely before starting engine.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

62. Start engine, release brake, and run at full throttle (2850 rpm ± 50).
63. Adjust flow lock tool (3) to allow pump to produce 15 gpm (57 lpm) in the forward direction.
64. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve until a reading of 1800 psi (124 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.
65. After warming the hydraulic oil, verify flow lock tool is adjusted to allow pump to produce 15 gpm (57 lpm) in the forward direction.
66. Slowly close flow meter valve until pressure reaches 2700 psi (186 bar). Read and record loaded flow.
67. Stop engine, apply brake, and return flow lock tool back to neutral position.
68. Calculate right rear wheel motor leakage. (Step 56 – Step 66 / Step 56 x 100 = Leak Percentage)

    Is right rear wheel motor leakage 10% or less?

    YES *The right rear wheel motor is good. Proceed to step 69.*

    NO *Proceed to next question.*

    Is right rear wheel motor leakage 11% to 20%?

    YES *The right rear wheel motor is marginal. Repair or replace as needed.*

    NO *Proceed to next question.*

    Is right rear wheel motor leakage 21% or more?

    YES *Repair or replace right rear wheel motor. (See "Rear Wheel Motor" on page 5-39.)*
69. Disconnect and remove test equipment. Install all hoses and fittings as noted prior to removal.
70. Install and connect all components as noted prior to test.
71. Check hydraulic oil level. Add oil as needed. (Refer to "Safety, Operation, and Maintenance Manual" for correct oil specifications.)

Neutral Adjust—Servo

See Figures 5-23 and 5-24.

WARNING

The hydraulic system is under pressure, and the oil will be hot.

- **Always relieve pressure in the hydraulic system before performing service.**
- **Failure to follow appropriate safety precautions may result in death or serious injury.**

Required Tools and Materials
• -6 ORB Test Hose 4000 psi (276 bar) • Pressure Gauge 4000 psi (276 bar)

1. Remove the center floorboard and the seat.
2. Bypass seat switch.

⚠ WARNING

Prevent personal injury. Use properly rated lifting devices. Always be sure load is balanced before lifting.

Support the machine properly using jack stands.

IMPORTANT

It is important to lift and support the machine or the machine will move.

3. Lift the machine so that front and rear wheels are off the ground and support with stands.

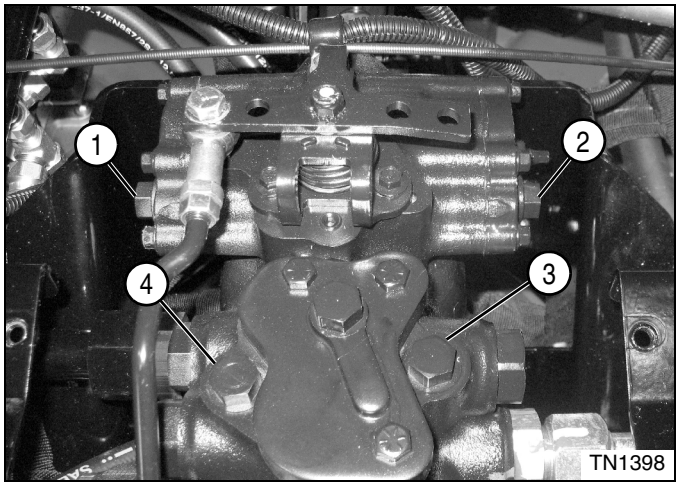


Figure 5-23

4. Install test hose between ports (1 and 2).
5. Install pressure gauges to the system pressure gauge ports (3 and 4).

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

6. Start engine, release brake, and run at full throttle (2850 rpm ± 50).
7. Operate hydraulic system until oil temperature is at 120—150°F (49—65°C).

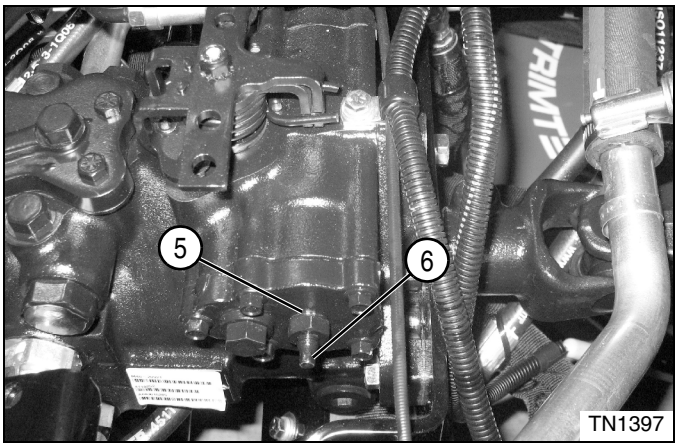


Figure 5-24

8. Loosen servo lock nut (5) while holding the servo adjustment screw (6) in position.
9. Turn servo adjustment screw (6) until the two system pressure gauge readings are equal.
10. Turn servo adjustment screw (6) clockwise until one of the system pressures starts to increase.
11. Noting the amount of rotation, turn servo adjustment screw (6) counterclockwise until the other system pressure starts to increase.
12. Turn servo adjustment screw (6) clockwise half the amount of rotation noted earlier.
13. While holding servo adjustment screw (6) from turning, tighten servo lock nut (5) to 15 ± 3 lb-ft (20 ±4 N·m).
14. Stop the engine and apply brake.
15. Remove pressure gauges from ports (3 and 4) and remove hose between ports (1 and 2).
16. Install and connect all components as noted prior to adjustment.

Repair

Drive Shaft

Removal and Installation

See Figure 5-25.

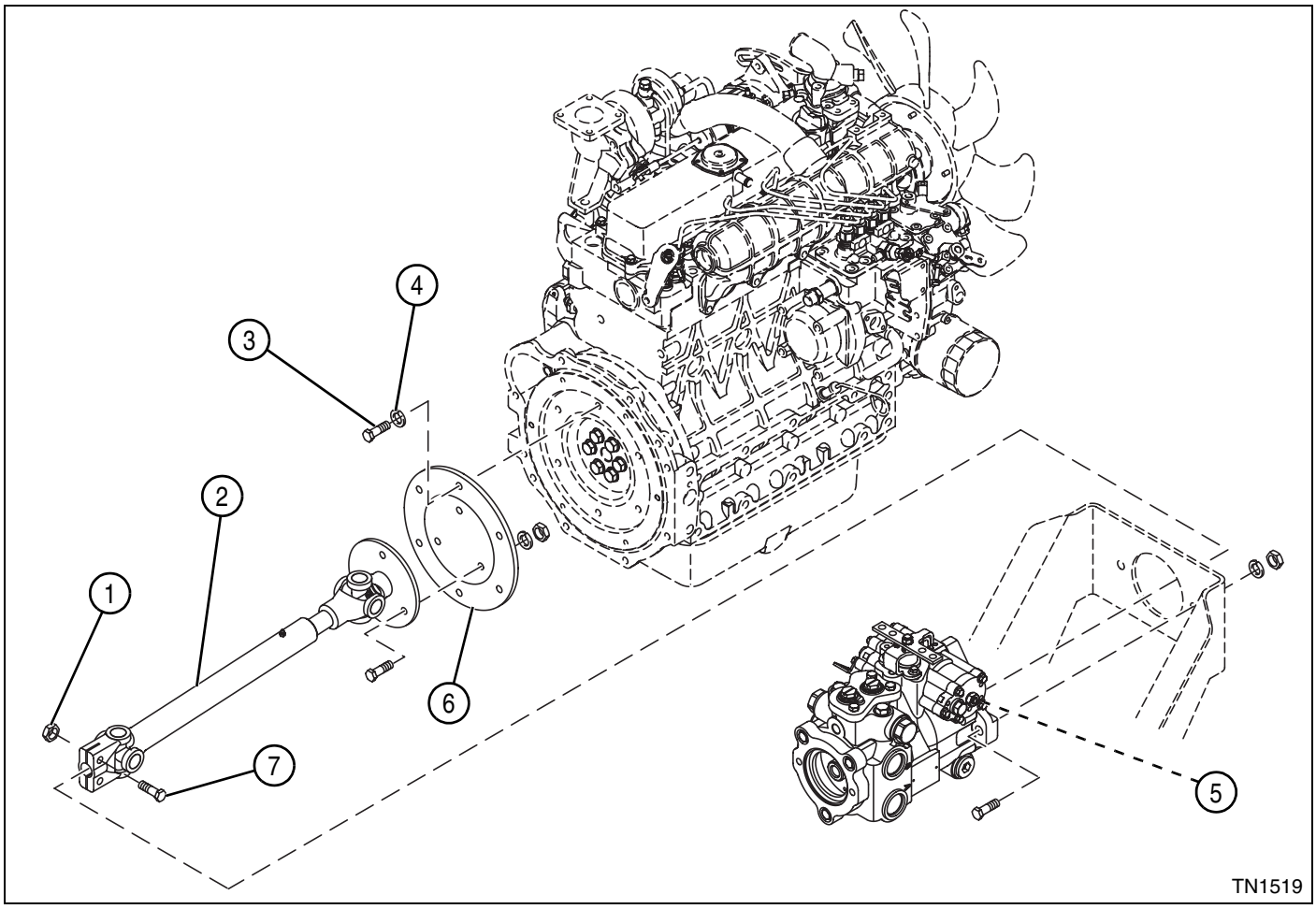


Figure 5-25

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove nut (1) and screw (7).
3. Disconnect drive shaft (2) from traction pump input shaft (5).
4. Remove screws (3) and washers (4).
5. Remove drive shaft (2) and drive shaft flange (6) as an assembly.
6. Remove drive shaft flange (6) from drive shaft (2).

Installation Note

Install the drive shaft by reversing the order of removal.

Traction Pump

Removal and Installation

See Figures 5-26 and 5-27.

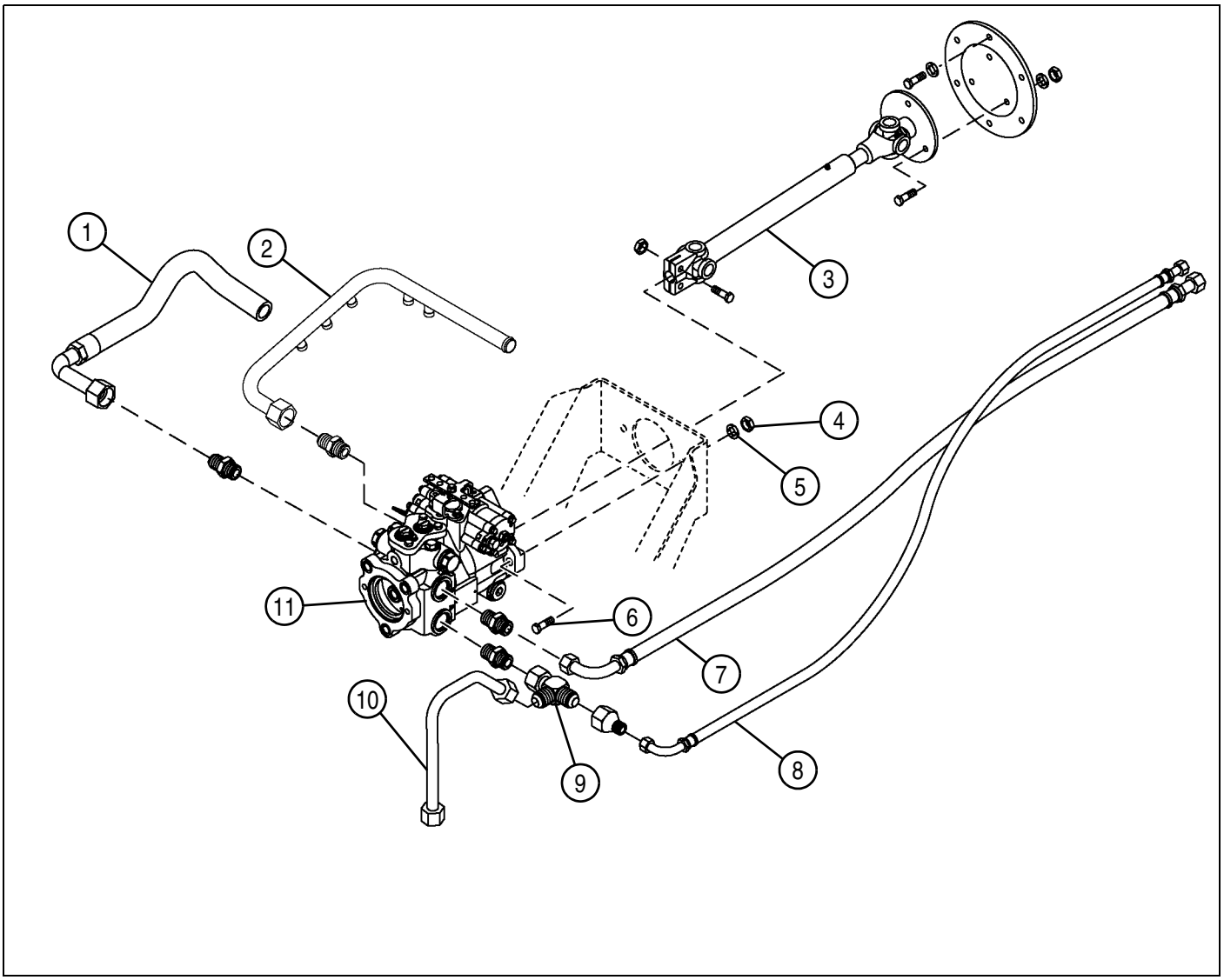


Figure 5-26

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove the center floorboard and the seat.
3. Drain hydraulic oil tank.
4. Remove gear pump. (See “Gear Pump” on page 6-41.)
5. Disconnect hoses (1 and 2).
6. Disconnect tee fitting (9).
7. Disconnect hoses (7 and 8).

NOTES

- *Label all hydraulic hoses before disconnecting to ensure correct installation.*
- *Close all openings with caps or plugs to prevent contamination.*

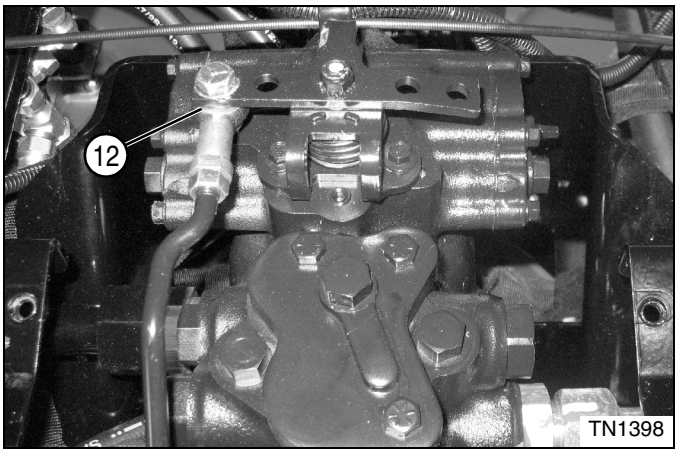


Figure 5-27

8. Disconnect control rod (12).
9. Disconnect drive shaft (3).

WARNING

The traction pump weighs approximately 131 lb (59 kg). Prevent personal injury. Use a properly rated lifting device. Always be sure the load is balanced before lifting.

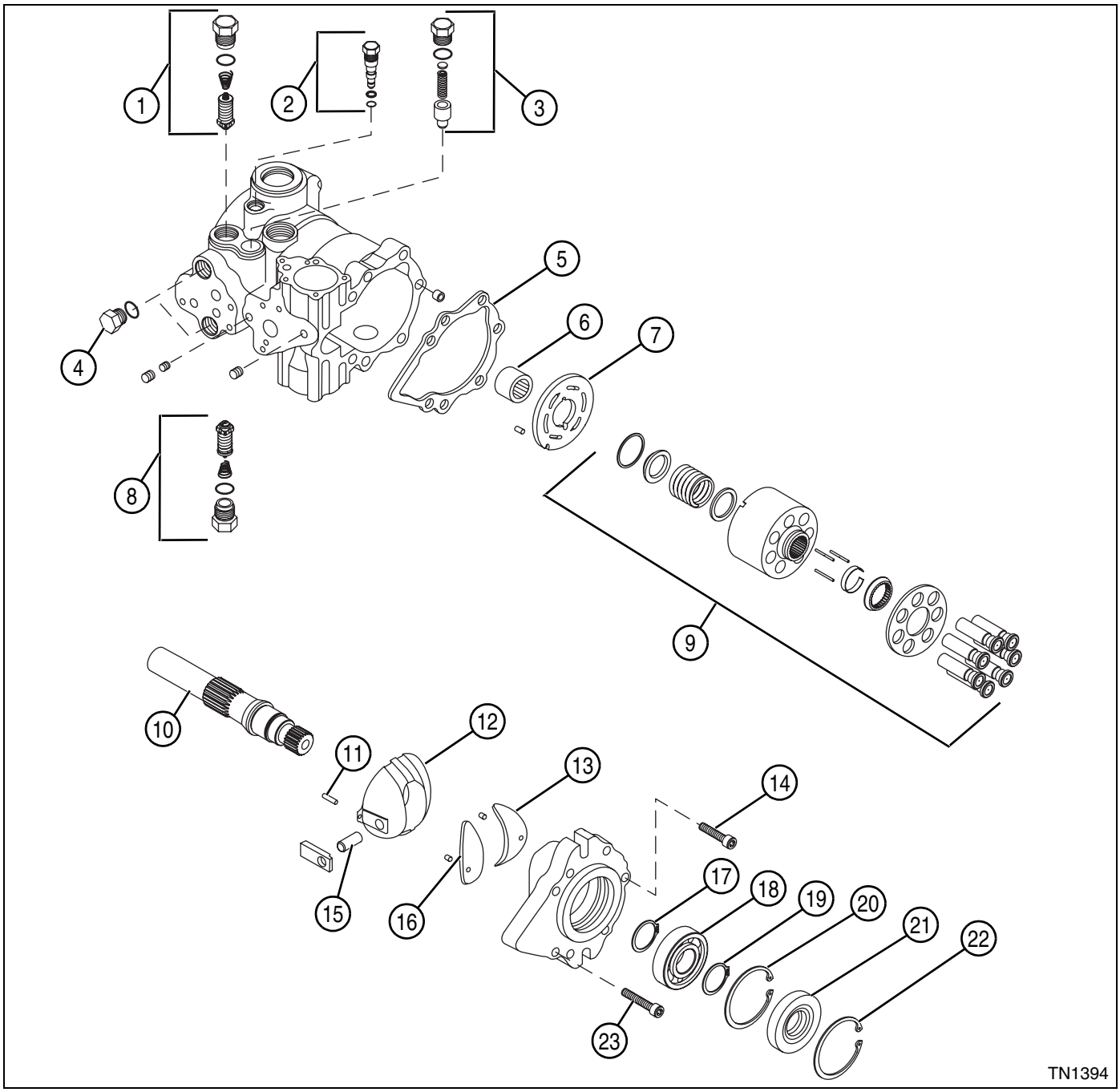
10. Attach a suitable lifting device to the traction pump (11).
11. Remove nuts (4), lock washers (5), and screws (6).
12. Remove traction pump (11).

Installation Notes

- *Install the hydrostatic pump by reversing the order of removal.*
- *Ensure new O-rings are in place before installing hoses on fittings.*
- *Pressure filter traction system. (See “Portable In-Line Filter” on page 5-2.)*
- *Fill the hydraulic tank. (Refer to “Safety, Operation, and Maintenance Manual” for the correct oil specifications.)*
- *Start engine. Check for leaks and repair as necessary.*

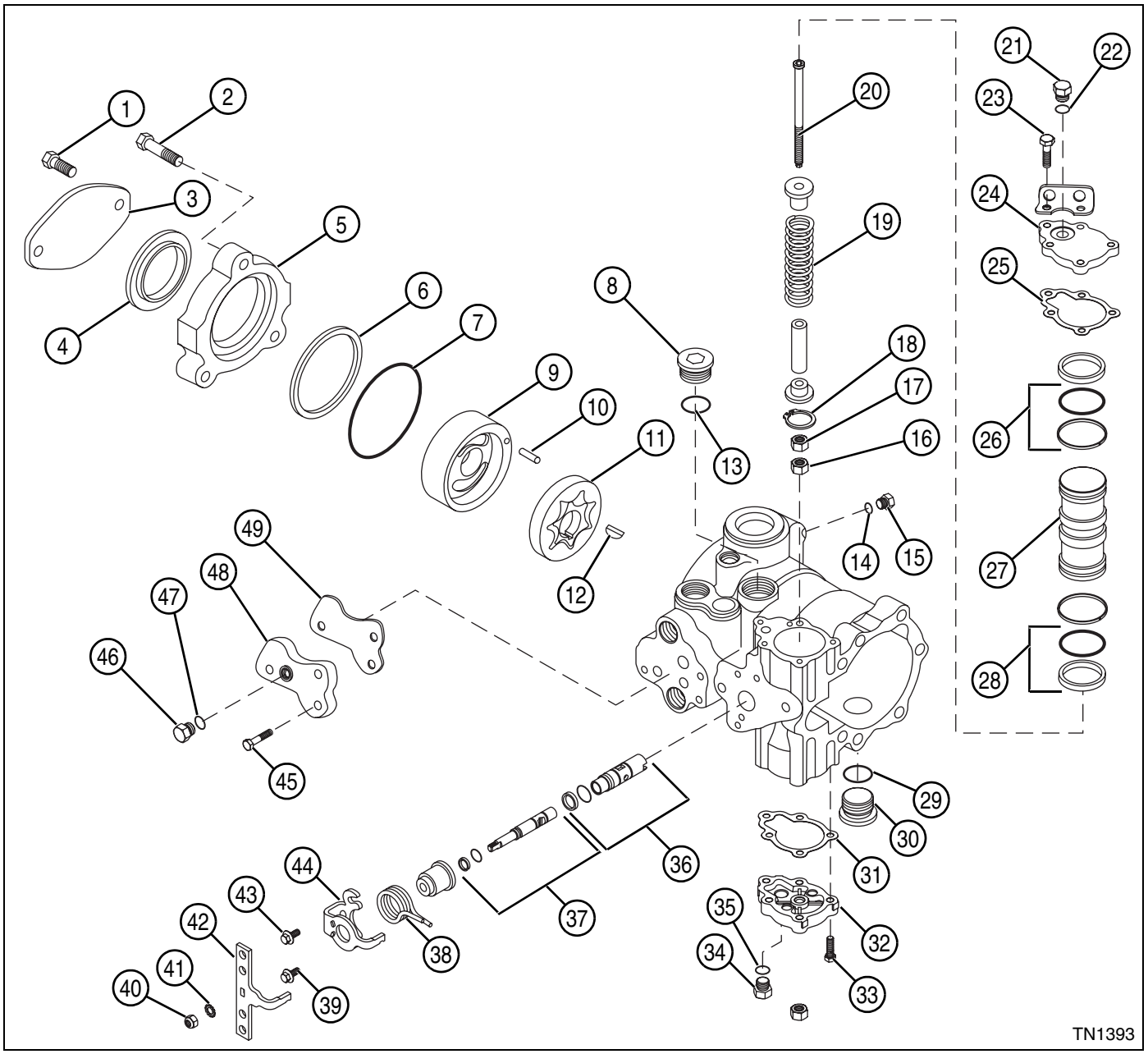
Disassembly, Inspection, and Assembly

See Figures 5-28 and 5-29.



1	Relief Valve	9	Cylinder Block Kit	17	Ring
2	Bypass Valve	10	Pump Shaft	18	Roller Bearing
3	Charge Pressure Relief Valve	11	Pin	19	Ring
4	Plug	12	Variable Swash Plate	20	Retaining Ring
5	Front Cover Gasket	13	Journal Bearing	21	Shaft Seal
6	Needle Bearing	14	Screw	22	Ring
7	Valve Plate	15	Pin	23	Screw
8	Relief Valve	16	Journal Bearing		

Figure 5-28



1	Screw	14	O-Ring	27	Piston	40	Nut
2	Screw	15	Plug	28	Piston Ring Kit	41	Washer
3	Flange Cover	16	Nut	29	O-Ring	42	Control Handle
4	Flange	17	Nut	30	Plug	43	Screw
5	Pad Adapter	18	Snap Ring	31	Servo Cover Gasket	44	Neutral Bracket
6	Temper Load Ring	19	Spring	32	Servo Cover	45	Screw
7	O-Ring	20	Screw	33	Screw (5)	46	Plug
8	Plug	21	Plug	34	Plug	47	O-Ring
9	Gerotor Cover	22	O-Ring	35	O-Ring	48	Suction Filter Adaptor
10	Pin	23	Screw	36	Sleeve Assembly	49	Suction Filter Adaptor Seal
11	Gerotor	24	Servo Cover	37	Spool Assembly		
12	Drive Key	25	Servo Cover Gasket	38	Neutral Return Spring		
13	O-Ring	26	Piston Ring Kit	39	Screw		

Figure 5-29

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove traction pump. (See “Traction Pump” on page 5-27.)
3. Disassemble traction pump as shown in Figure 5-29 on page 5-30.
4. Place parts in assembly order on a clean work area as they are removed.

NOTICE

It is important that all pump parts are absolutely clean, as contamination can result in serious damage and/or improper operation.

Never use shop towels or rags to dry parts after cleaning, as lint may clog passages. Dry parts using compressed air.

Inspection Notes

- *Keeping parts in assembly order, clean and air dry each item for inspection.*
- *Inspect for worn or defective parts.*
- *Look for metal chips or slivers during cleaning (an indication of damage to pump or other hydraulic component).*
- *Inspect all parts for cracks, nicks, burrs, and excessive wear. Inspect for scoring, galling, and scratches on surfaces. Replace parts as necessary.*

Assembly Notes

Required Materials
Overhaul Seal and Gasket Kit

- *Assemble the pump by reversing the order of disassembly.*
- *Install new O-rings and seals. Use clean grease to keep seals in position.*

4WD Valve

Removal and Installation

See Figure 5-30.

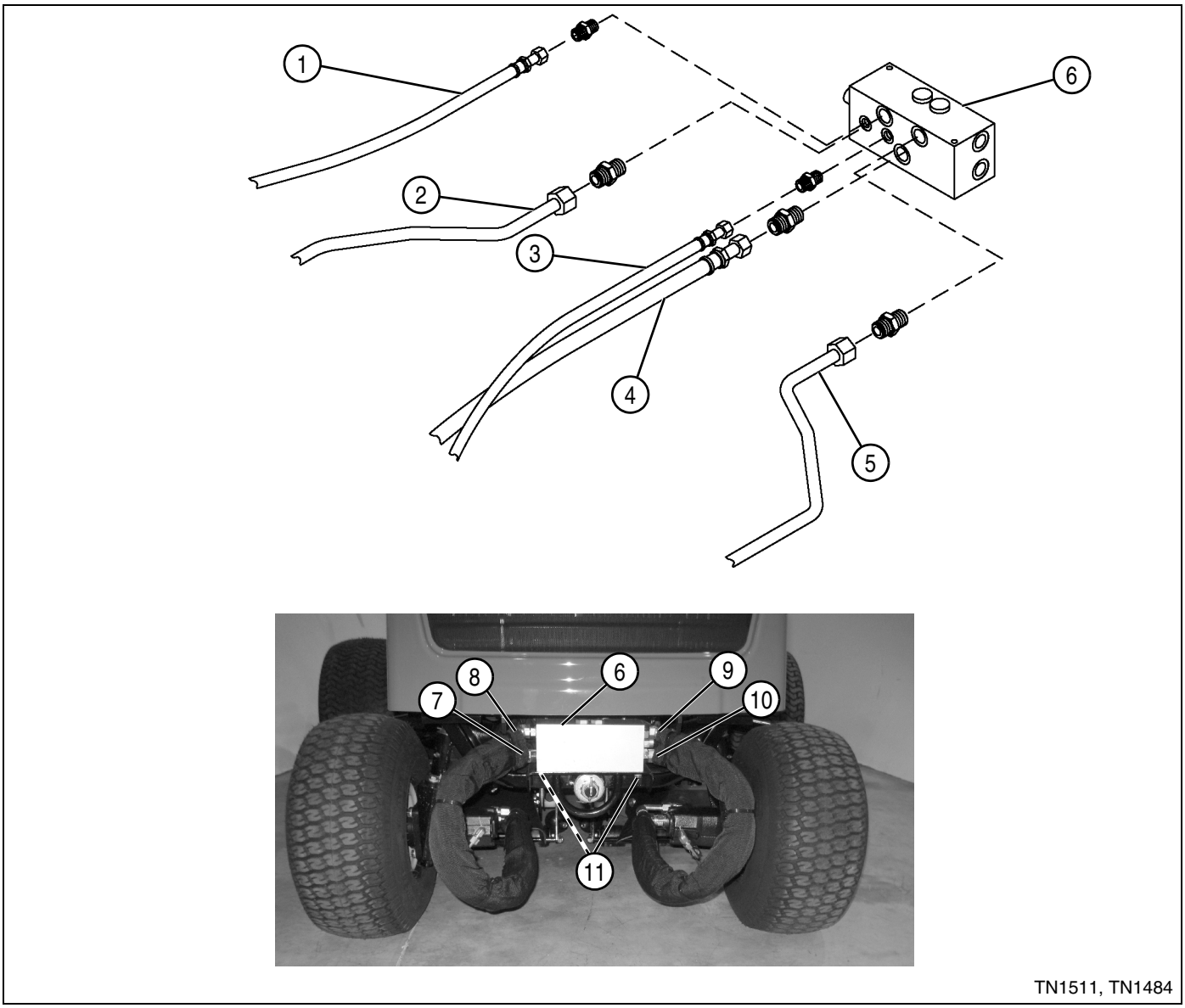


Figure 5-30

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Drain hydraulic tank.
3. Label all hydraulic hoses to ensure correct installation.
4. Disconnect hoses (1—5).
5. Disconnect hoses (7—10).
6. Remove mounting screws, flat washers, and lock washers (11).
7. Remove 4WD valve (6).

Installation Notes

- *Install the 4WD valve by reversing the order of removal.*
- *Ensure new O-rings are in place before installing hoses on fittings.*
- *Pressure filter traction system. (See "Portable In-Line Filter" on page 5-2.)*
- *Fill the hydraulic tank. (Refer to "Safety, Operation, and Maintenance Manual" for the correct oil specifications.)*
- *Start engine. Check for leaks and repair as necessary.*

Disassembly, Inspection, and Assembly

See Figures 5-31 and 5-32.

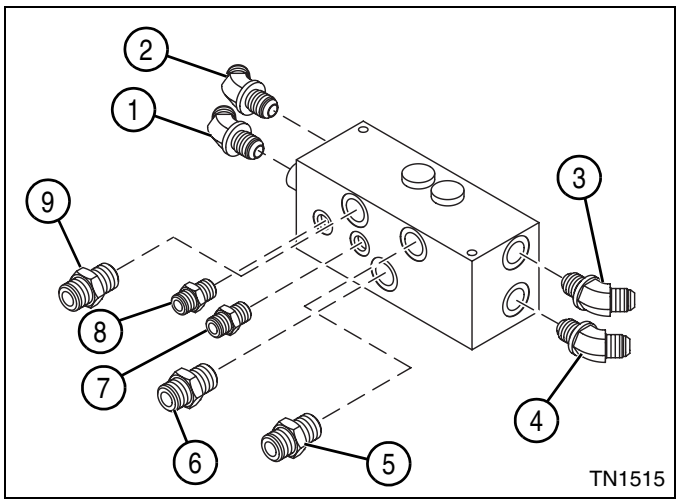


Figure 5-31

1. Remove fittings (1—9) from the 4WD valve.

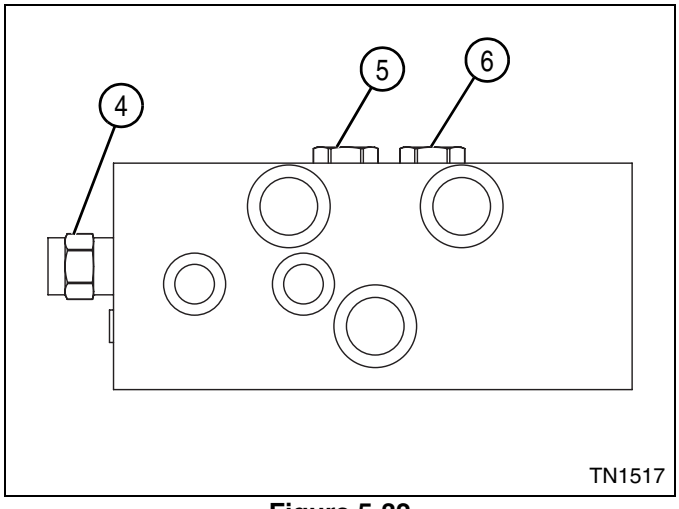


Figure 5-32

2. Remove hot oil shuttle (4).
3. Remove check valves (5 and 6).

NOTICE

It is important that all component parts are absolutely clean, as contamination can result in serious damage and/or improper operation.

Never use shop towels or rags to dry parts after cleaning, as lint may clog passages. Dry parts using compressed air.

4. Clean all parts using clean solvent, and dry using compressed air.
5. Inspect all parts for wear or damage. Replace parts as needed.

Assembly Notes

NOTICE

It is important that all component parts are absolutely clean, as contamination can result in serious damage and/or improper operation.

Never use shop towels or rags to dry parts after cleaning, as lint may clog passages. Dry parts using compressed air.

Required Materials
Seal Kit, Check Valve (Jacobsen P/N 5003579) Seal Kit, Pilot Operated Internal Vent Valve (Jacobsen P/N 5003579)

- *Assemble the 4WD valve by reversing the order of disassembly.*
- *Lubricate all O-rings prior to assembly.*

Front Wheel Motor

Removal and Installation

See Figure 5-33.

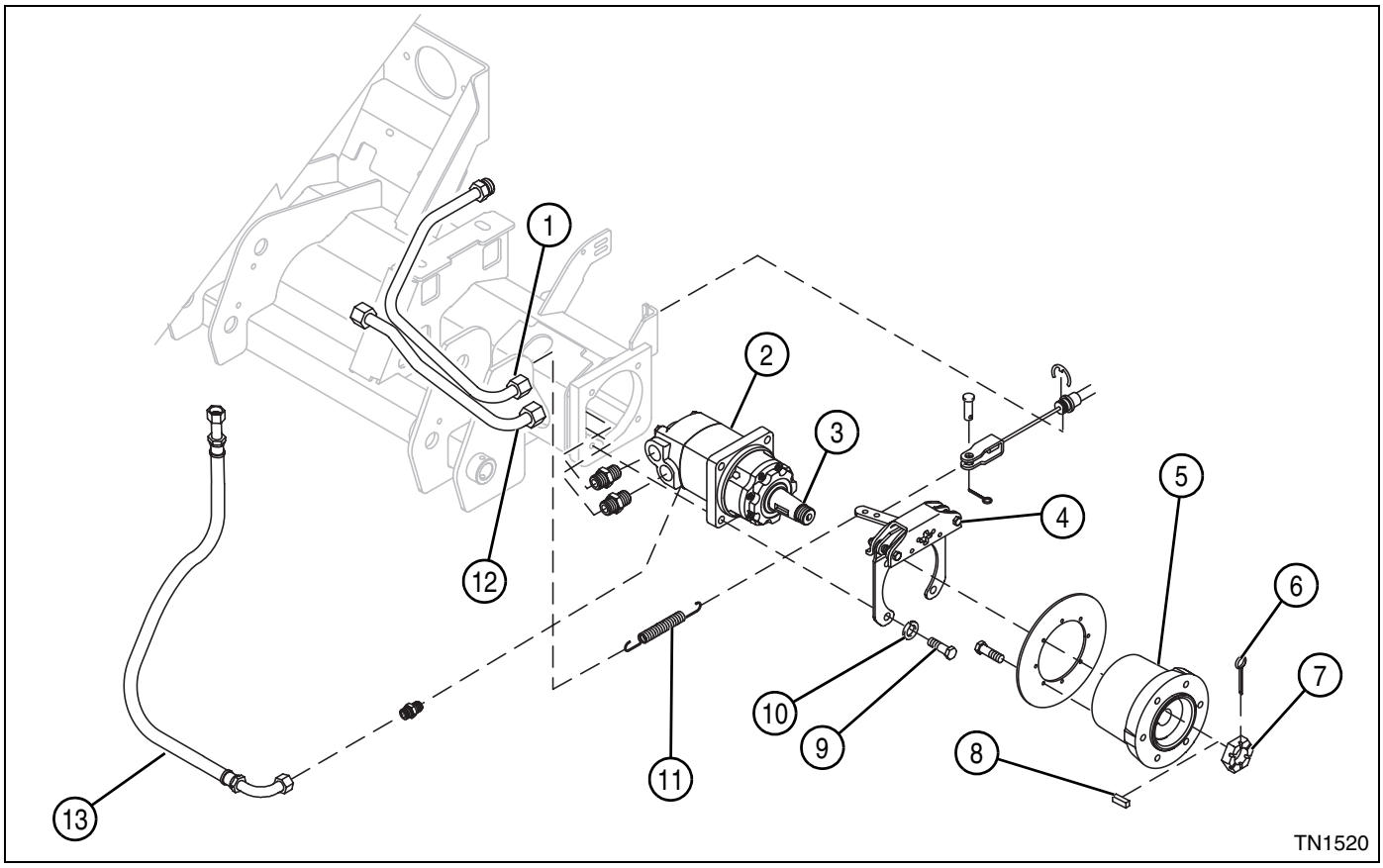


Figure 5-33

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove front wheel. (See “Front Wheels” on page 9-11.)

NOTES

- *Label all hydraulic hoses before disconnecting to ensure correct installation.*
- *Plug hydraulic hoses after disconnecting to prevent the loss of hydraulic oil.*

3. Remove brake return spring (11).
4. Remove brake housing and bracket (4).
5. Remove cotter pin (6).

CAUTION

The wheel hub may move unexpectedly when using a puller. To prevent injury and/or property damage, do not remove the castle nut until the wheel hub has been loosened from the wheel motor shaft.

6. Loosen, but do not remove, the castle nut (7).
7. Loosen the wheel hub (5) from the motor shaft (3) using a puller.
8. Remove the castle nut (7) and wheel hub (5) from motor shaft (3).
9. Remove key (8) from motor shaft (3).
10. Disconnect hoses (1,12, and 13).
11. Remove four screws (9) and lock washers (10).
12. Remove motor (2) from the axle.

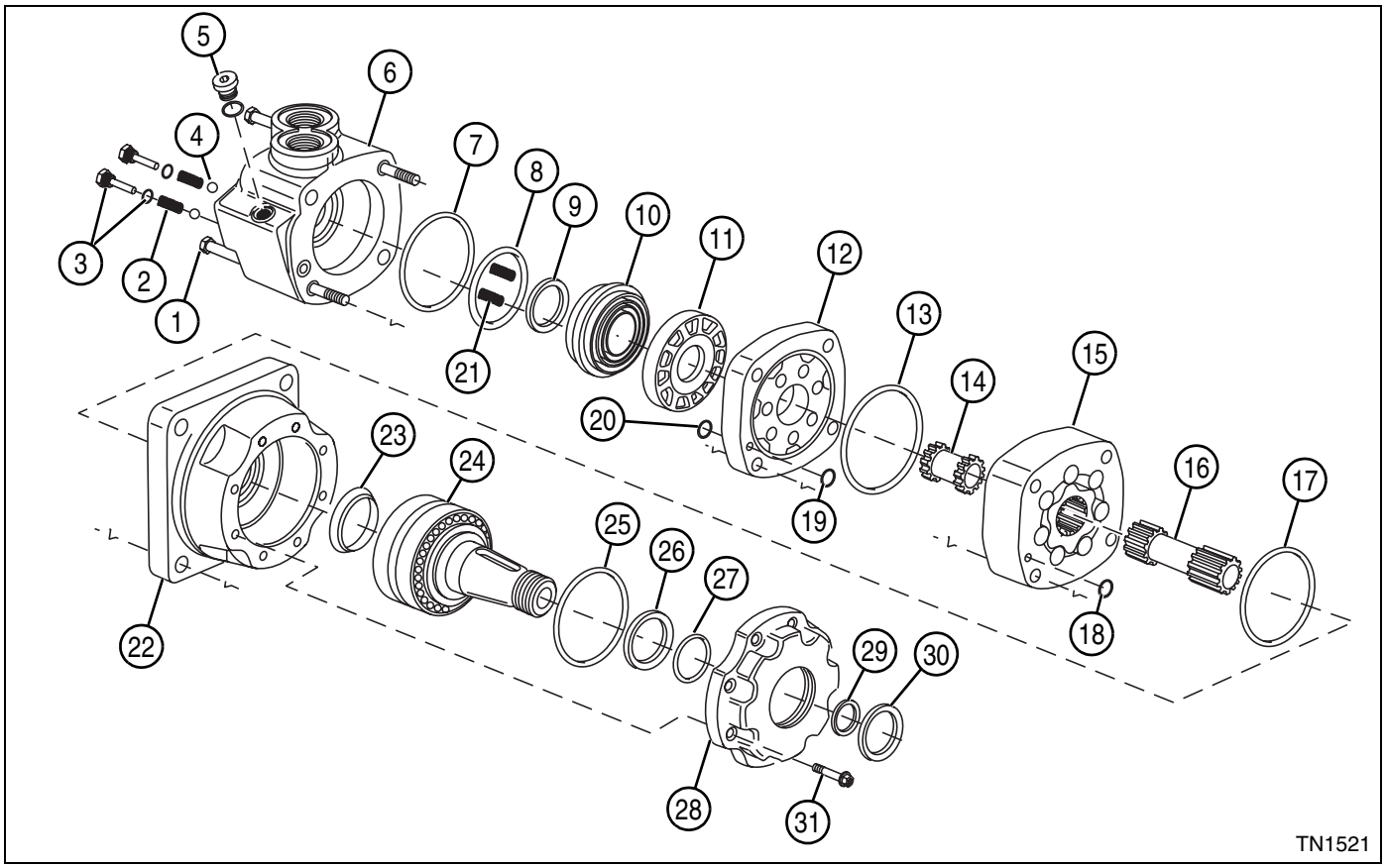
Installation Notes

Required Materials
Anti-Seize Compound

- *Install the front wheel motor by reversing the order of removal.*
- *Apply anti-seize compound to the motor shaft threads (3). Be careful not to apply anti-seize compound to the motor shaft.*
- *Install a new cotter pin (6) in castle nut (7) and motor shaft (3).*
- *Pressure filter traction system upon startup if metal debris is found in system oil or motor. (See “Portable In-Line Filter” on page 5-2.)*
- *Check hydraulic oil level. Add oil as needed. (Refer to “Safety, Operation, and Maintenance Manual” for the correct oil specifications.)*

Disassembly, Inspection, and Assembly

See Figures 5-34 through 5-37.



1	Screw (4)	9	Seal	17	Seal	25	Seal
2	Spring	10	Balance Ring and Pins	18	Seal	26	Seal
3	Check Plug Assembly (2)	11	Valve	19	Seal	27	Seal
4	Ball, Steel	12	Valve Plate	20	Seal	28	Front Retainer
5	Plug	13	Seal	21	Spring (2)	29	Seal
6	Valve Housing	14	Valve Drive	22	Bearing Housing	30	Seal
7	Seal	15	Geroler	23	Seal	31	Screw (8)
8	Seal	16	Drive	24	Shaft and Bearing Kit		

Figure 5-34

1. Disassemble front wheel motor as shown.
2. Place parts in assembly order on a clean work area as they are removed.

NOTICE

It is important that motor parts are marked and placed in assembly order to aid in assembly.

It is important that all motor parts are absolutely clean, as contamination can result in serious damage and/or improper operation.

Never use shop towels or rags to dry parts after cleaning, as lint may clog passages. Dry parts using compressed air.

Inspection Notes

- *Keeping parts in assembly order, clean and air dry each item for inspection.*
- *Inspect for worn or defective parts.*
- *Look for metal chips or slivers during cleaning (an indication of damage to pump or other hydraulic component).*
- *Inspect all parts for cracks, nicks, burrs, and excessive wear. Inspect for scoring, galling, and scratches on surfaces. Replace parts as necessary.*

Assembly Notes

NOTICE

It is important that all motor parts are absolutely clean, as contamination can result in serious damage and/or improper operation.

Never use shop towels or rags to dry parts after cleaning, as lint may clog passages. Dry parts using compressed air.

Required Materials
Seal Kit (Jacobsen P/N 557651) Seal Kit (Jacobsen P/N 5002111)

- *Assemble the front wheel motor by reversing the order of disassembly.*
- *Lubricate all O-rings prior to assembly.*
- *Time the motor correctly.*
- *Tighten retainer screws and valve housing screws in correct sequence.*
- *Install check plugs (3) and tighten to 60—120 lb-in. (7—14 N•m).*
- *Install plug (5) and tighten to 150 lb-in. (17 N•m).*
- *Pressure filter traction system upon startup if metal debris is found in system oil or motor. (See “Portable In-Line Filter” on page 5-2.)*

Front Wheel Motor Timing

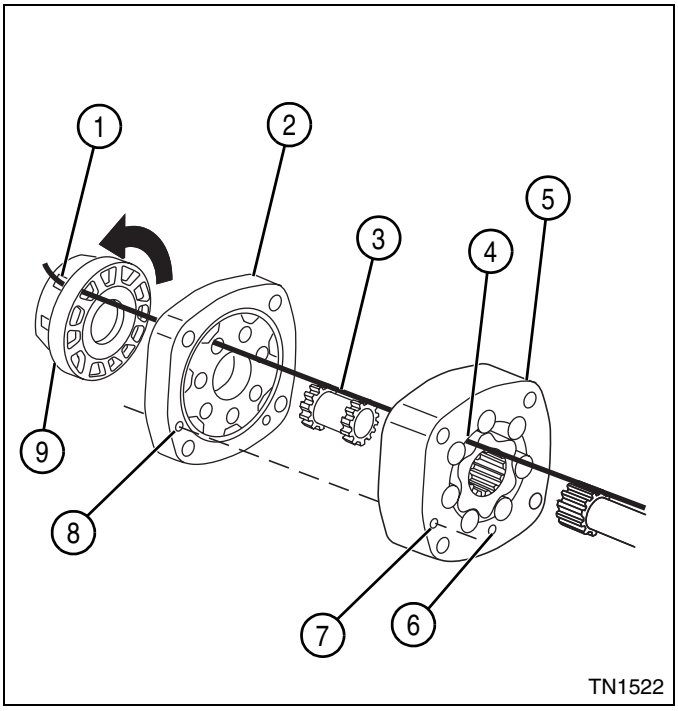


Figure 5-35: Correct Motor Timing

1. Locate the largest open pocket (4) in geroler (5). Mark the location of the pocket on the outside edge of geroler.
2. Align the case drain hole (7) and the pressure relief hole (6) in the geroler with the case drain hole and pressure relief hole in the bearing housing. Install the geroler on the bearing housing. Retain the rollers in the outer geroler ring if they are loose.
3. Install the valve drive (3) in geroler (5).
4. Lubricate the seal and install it in the valve plate (2).
5. Align the case drain hole (8) in the valve plate (2) with the case drain hole (7) in the geroler (5). Install the valve plate (2) with the seal side toward the geroler.
6. Locate the slot in the valve plate (2) that is in line with the largest open pocket (4) of geroler.
7. Locate any side valve opening (1) through to the face of the valve. Line up the opening with the open slot of the valve plate that is in line with the largest open pocket (4) of geroler. Rotate valve (9) clockwise 1/2 spline tooth to engage with the valve drive spline.

Retainer Screw Torque Sequence

See Figure 5-36.

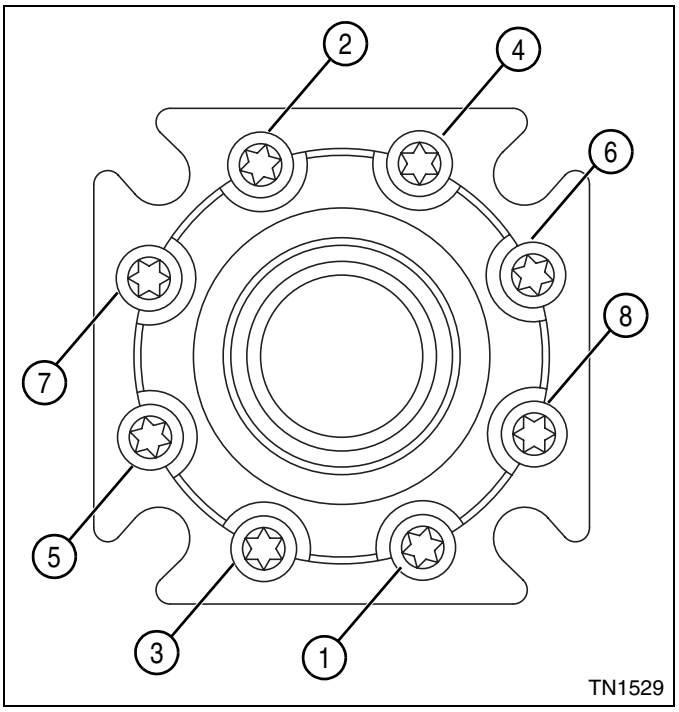


Figure 5-36

1. Install retainer screws (1—8) finger tight in sequence as shown above.
2. Tighten retainer screws (1—8) to 50 lb-in. (6 N•m) in sequence as shown above.
3. Tighten retainer screws (1—8) to 300 lb-in. (34 N•m) in sequence as shown above.

Valve Housing Screw Torque Sequence

See Figure 5-37.

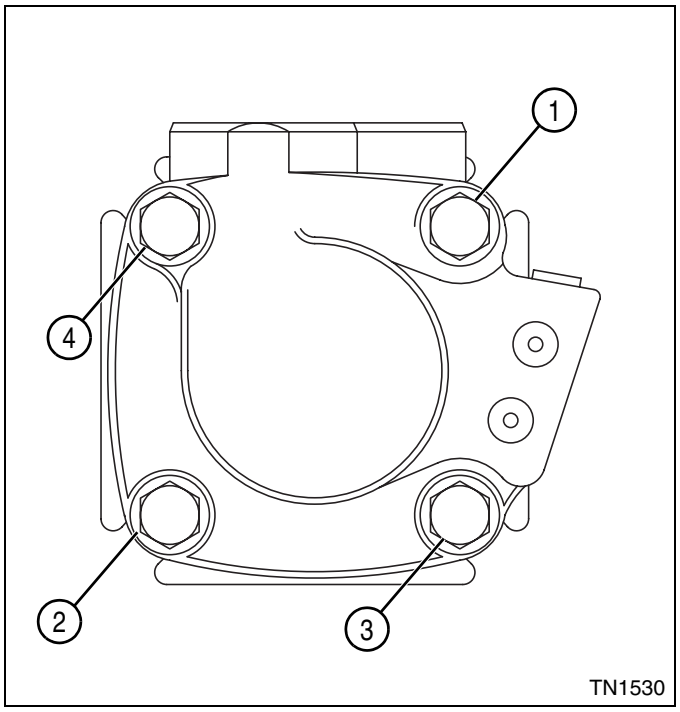


Figure 5-37

1. Install valve housing screws (1—4) finger tight in sequence as shown.
2. Tighten valve housing screws (1—4) to 750 lb-in. (85 N•m) in sequence as shown.

Rear Wheel Motor

Removal and Installation

See Figure 5-38.

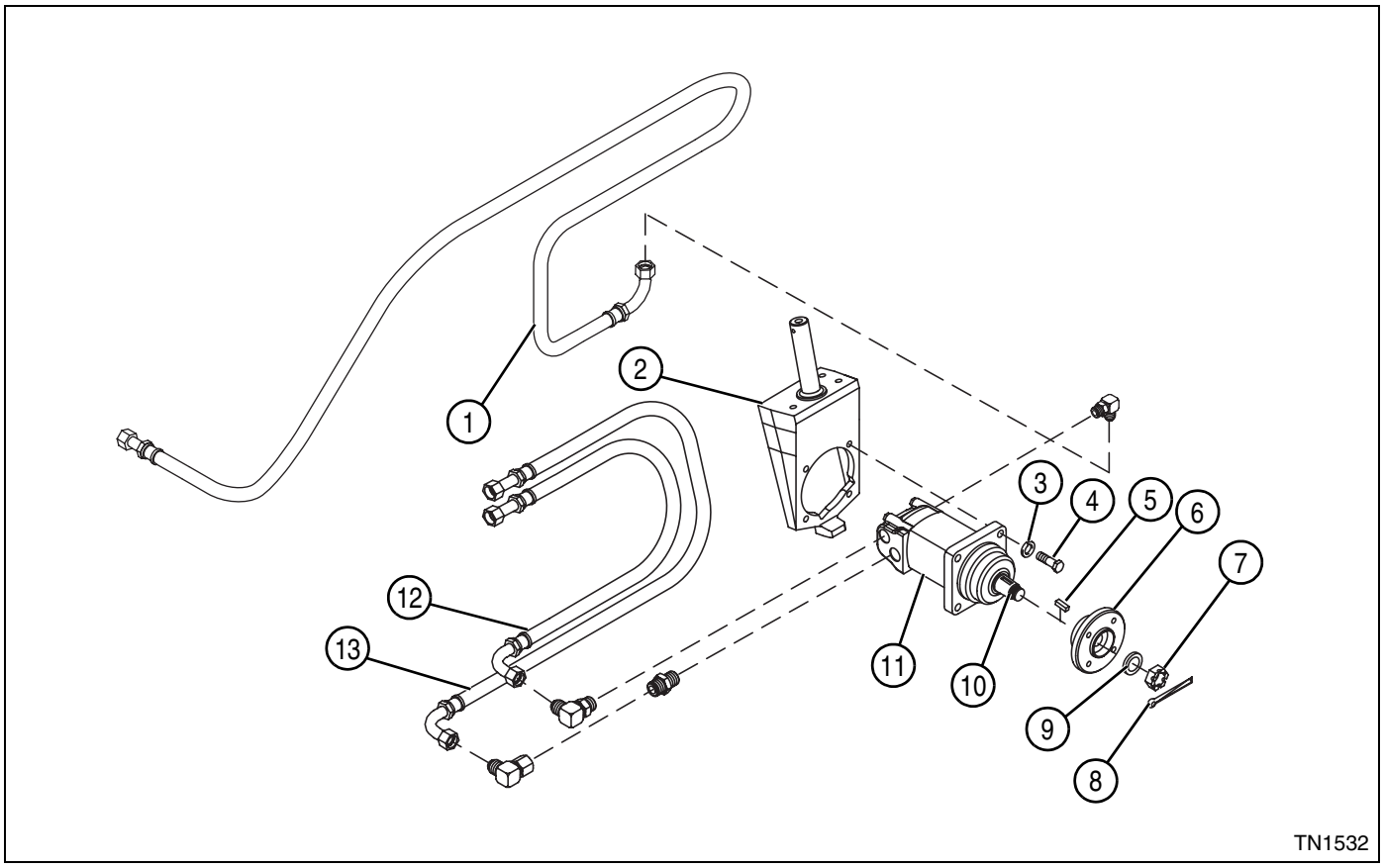


Figure 5-38

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove rear wheel. (See “Rear Wheels” on page 9-11.)

NOTES

- *Label all hydraulic hoses before disconnecting to ensure correct installation.*
- *Plug hydraulic hoses after disconnecting to prevent the loss of hydraulic oil.*

3. Remove cotter pin (8).

CAUTION

The wheel hub may move unexpectedly when using a puller. To prevent injury and/or property damage, do not remove the castle nut until the wheel hub has been loosened from the wheel motor shaft.

4. Loosen, but do not remove, the castle nut (7).
5. Loosen the wheel hub (6) from the motor shaft (10) using a puller.
6. Remove the castle nut (7), washer (9), and wheel hub (6) from motor shaft (10).
7. Remove key (5) from motor shaft (10).
8. Disconnect hoses (1, 12, and 13).
9. Remove four screws (4) and lock washers (3).
10. Remove motor (11) from motor mount (2).

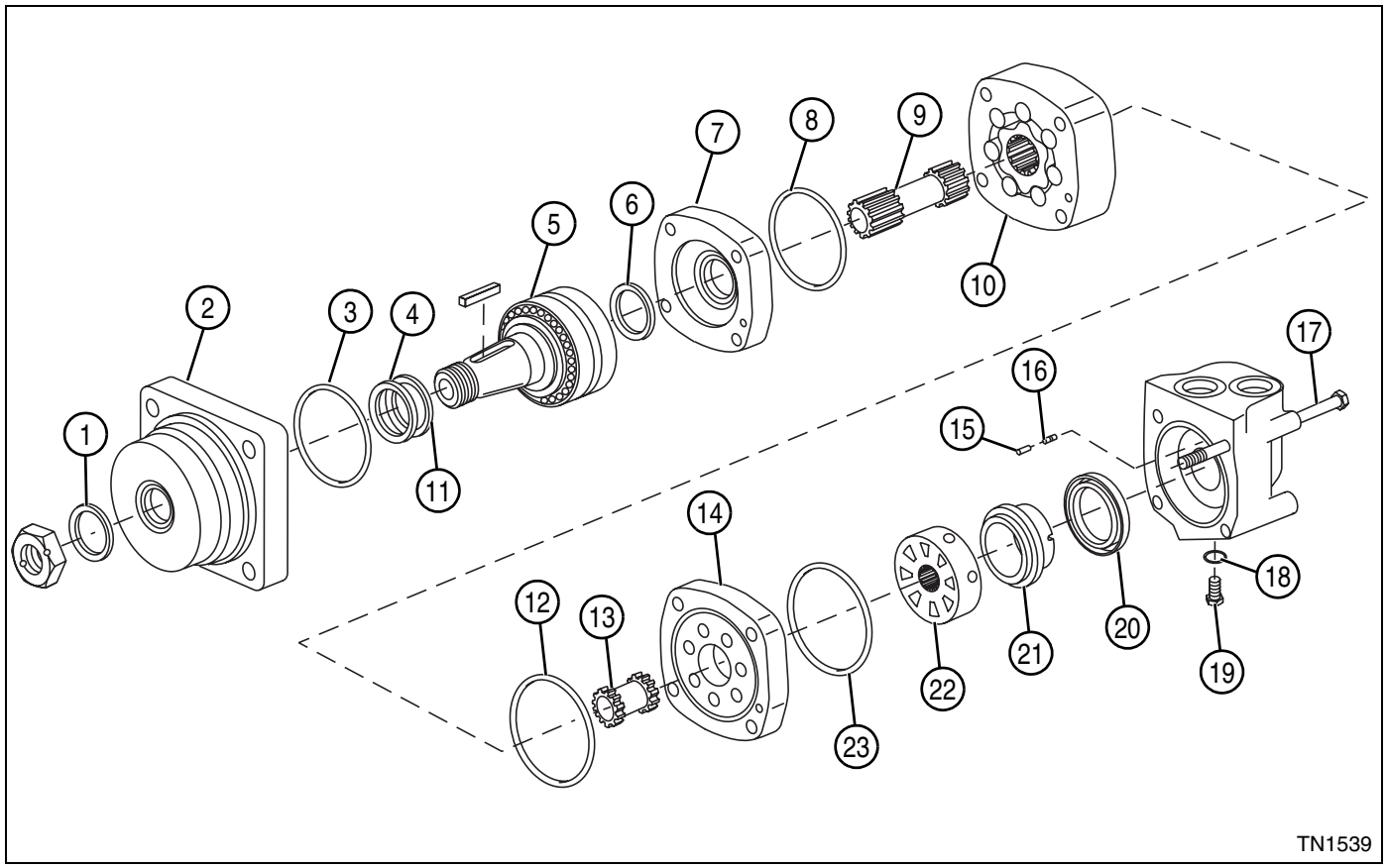
Installation Notes

Required Materials
Anti-Seize Compound

- *Install the rear wheel motor by reversing the order of removal.*
- *Apply anti-seize compound to the motor shaft threads (10). Be careful not to apply anti-seize compound to the motor shaft.*
- *Install a new cotter pin (8) in castle nut (7) and motor shaft (10).*
- *Pressure filter traction system upon startup if metal debris is found in system oil or motor. (See “Portable In-Line Filter” on page 5-2.)*
- *Check hydraulic oil level. Add oil as needed. (Refer to “Safety, Operation, and Maintenance Manual” for the correct oil specifications.)*

Disassembly, Inspection, and Assembly

See Figures 5-39 and 5-40.



1	Dust Seal	7	Wear Plate	13	Valve Drive	19	Plug
2	Bearing Housing	8	Seal	14	Valve Plate	20	Outer Face Seal
3	Seal Ring	9	Drive	15	Pin	21	Balance Ring
4	Backup Ring	10	Geroler	16	Spring	22	Valve
5	Shaft Seal	11	Shaft Seal	17	Valve Housing Screw (4)	23	Seal
6	Shaft and Bearing Kit	12	Seal	18	Seal		

Figure 5-39

1. Disassemble rear wheel motor as shown.
2. Place parts in assembly order on a clean work area as they are removed.

NOTICE

It is important that motor parts are marked and placed in assembly order to aid in assembly.

It is important that all motor parts are absolutely clean, as contamination can result in serious damage and/or improper operation.

Never use shop towels or rags to dry parts after cleaning, as lint may clog passages. Dry parts using compressed air.

Inspection Notes

- *Keeping parts in assembly order, clean and air dry each item for inspection.*
- *Inspect for worn or defective parts.*
- *Look for metal chips or slivers during cleaning (an indication of damage to pump or other hydraulic component).*
- *Inspect all parts for cracks, nicks, burrs, and excessive wear. Inspect for scoring, galling, and scratches on surfaces. Replace parts as necessary.*

5

Assembly Notes

NOTICE

It is important that all component parts are absolutely clean, as contamination can result in serious damage and/or improper operation.

Never use shop towels or rags to dry parts after cleaning, as lint may clog passages. Dry parts using compressed air.

Required Materials
Seal Kit (Jacobsen P/N 4134527)

- *Assemble the rear wheel motor by reversing the order of disassembly.*
- *Lubricate all O-rings prior to assembly.*
- *Time the motor correctly.*
- *Tighten valve housing screws (17) to 36—37 lb-ft (49—50 N•m).*
- *Pressure filter traction system upon startup if metal debris is found in system oil or motor. (See “Portable In-Line Filter” on page 5-2.)*

Rear Wheel Motor Timing

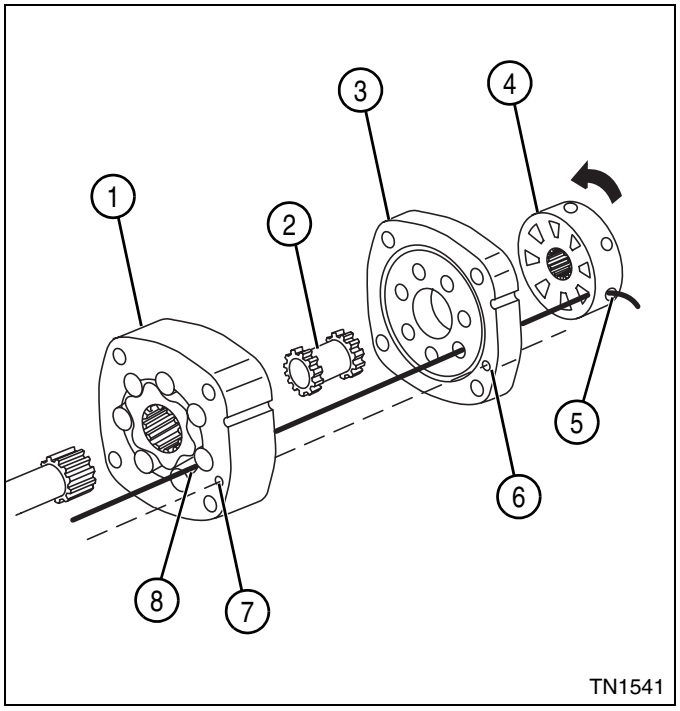


Figure 5-40: Correct Motor Timing

1. Locate the largest open pocket (6) in geroler (1). Mark the location of the pocket on the outside edge of geroler.
2. Align the case drain hole (7) in the geroler with the case drain hole in the bearing housing. Install the geroler on the bearing housing. Retain the rollers in the outer geroler ring if they are loose.
3. Install the valve drive (2) in geroler (1).
4. Lubricate the seal and install it in the valve plate (3).
5. Align the case drain hole (6) in the valve plate (3) with the case drain hole (7) in the geroler (1). Install the valve plate (3) with the seal side toward the geroler.
6. Locate the slot in the valve plate (3) that is in line with the largest open pocket (8) of geroler.
7. Locate any side valve opening (5) through to the face of the valve. Line up the opening with the open slot of the valve plate that is in line with the largest open pocket of geroler. Rotate valve (4) clockwise 1/2 spline tooth to engage with the valve drive.

Chapter 6

Hydraulics

6

JACOBSEN
A Textron Company

Specifications

Test and Adjustment Specifications

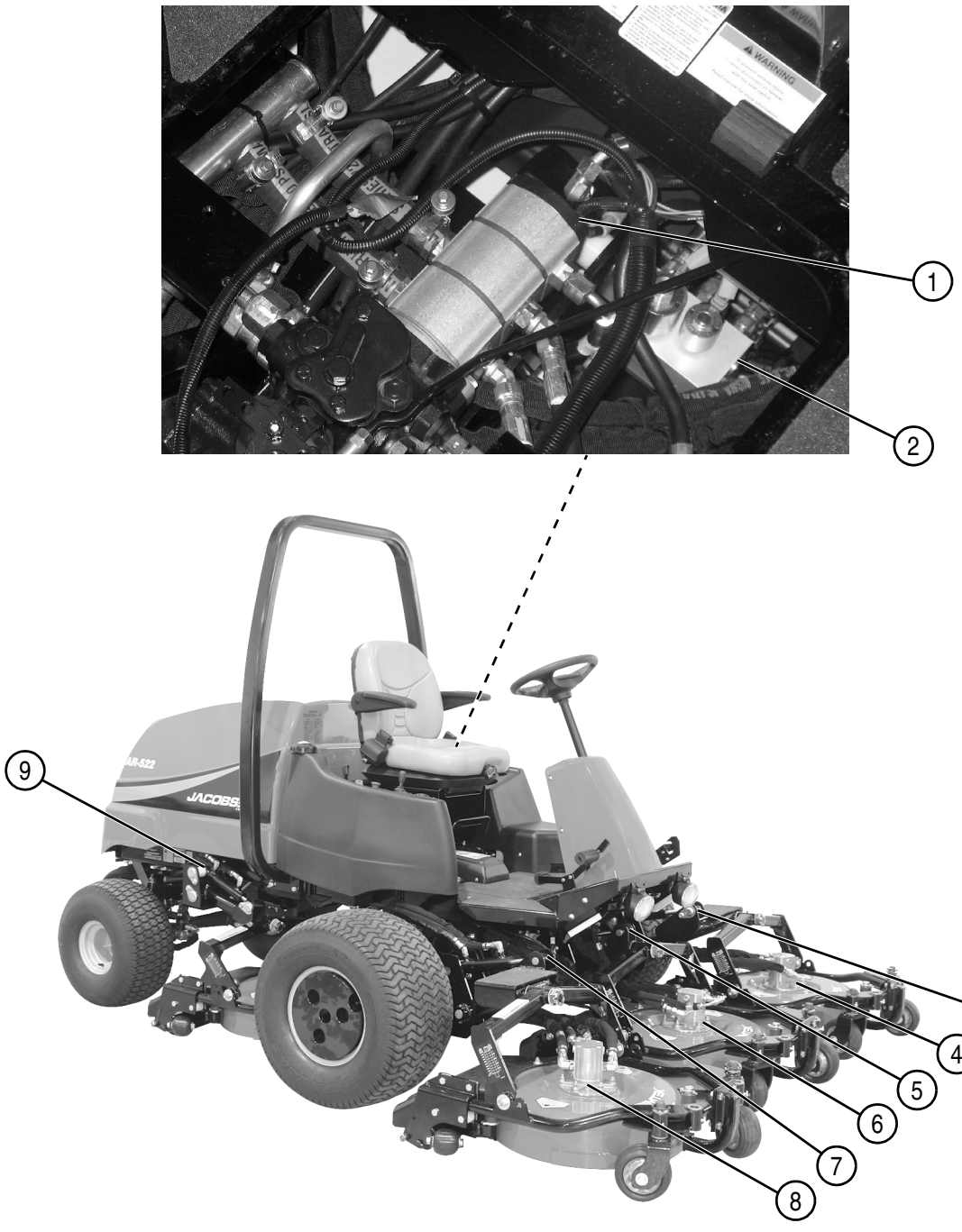
Specifications		
Front Cutting Unit Pump Flow	gpm (lpm)	10.8 (40.8) at 2850 rpm
Rear Cutting Unit Pump Flow	gpm (lpm)	10.8 (40.8) at 2850 rpm
Lift/Steer Pump Flow	gpm (lpm)	6.1 (23) at 2850 rpm
Hydraulic Leakage Percentage Ranges		0—10% = Good 11—20% = Marginal 21% and Beyond = Bad
Lift/Steer System Relief Valve Pressure Setting	psi (bar)	1740 (120)
Cutting Unit System Relief Valve Pressure Setting	psi (bar)	2600 (180)
Cutting Unit Motor Case Drain Rate		Less than 1 pint (0.47 L) per minute at 2000 psi (138 bar)

Repair Specifications

Specifications		
Gear Pump—Rear Cover-to-Pump Body Bolt Torque	lb-ft (N·m)	33 (45)
Cutting Unit Circuit Relief Valve Torque	lb-ft (N·m)	25 (34)
Hydraulic Oil Tank Capacity	gal (L)	14 (53)

Component Location

See Figures 6-1 and 6-2.



1	Gear Pump	6	Center Cutting Unit Motor
2	Lift Valve	7	Right Front Lift Cylinder
3	Left Front Lift Cylinder	8	Right Front Cutting Unit Motor
4	Left Front Cutting Unit Motor	9	Right Rear Lift Cylinder
5	Center Lift Cylinder		

Figure 6-1: Component Location—Right Side

1 Radiator/Hydraulic Oil Cooler
2 Hydraulic Oil Filter
3 Deck Valve
4 Right Rear Cutting Unit Motor

Figure 6-2: Component Location—Left Side

Hydraulic Schematic

See Figures 6-3 through 6-6.

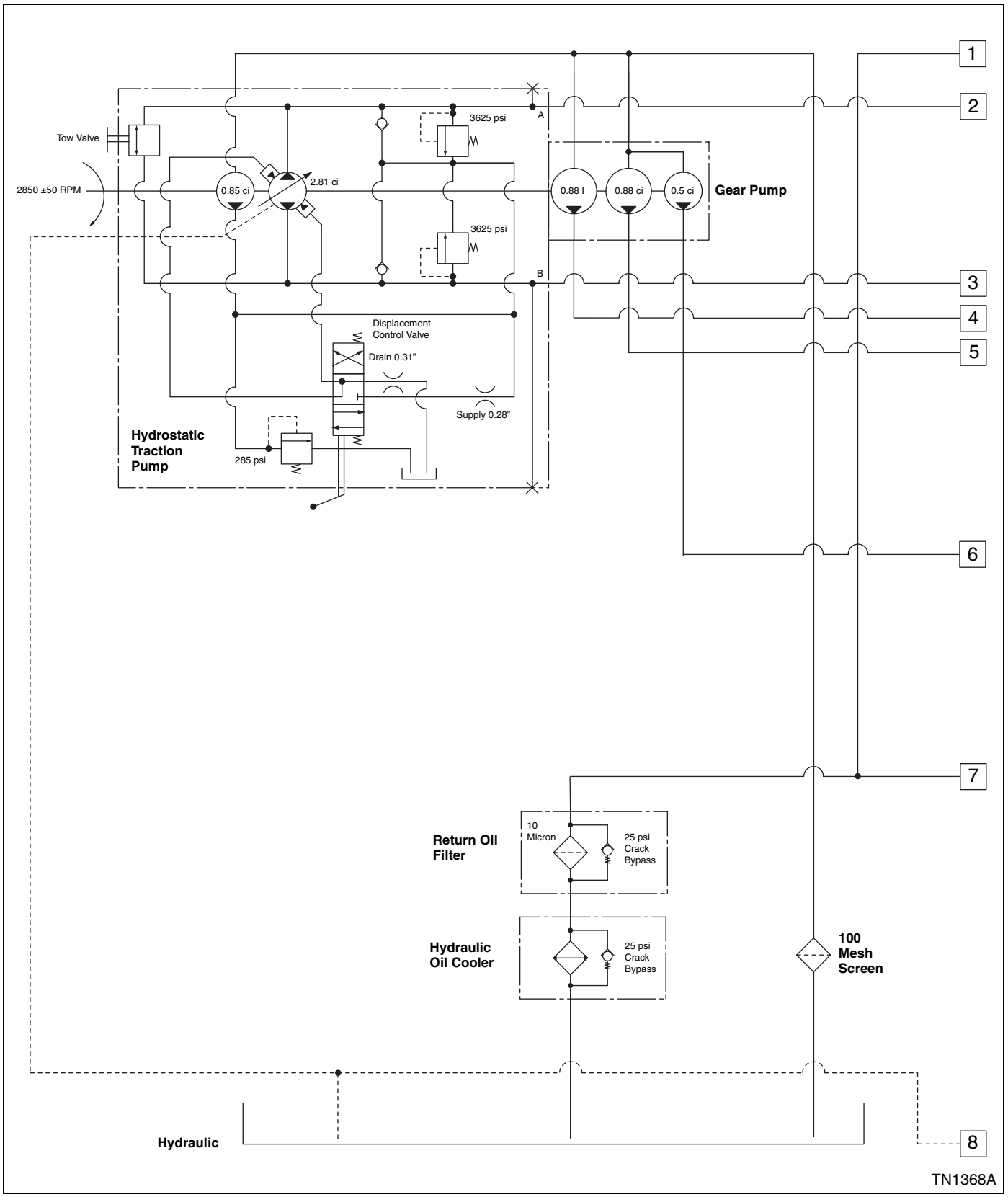


Figure 6-3

Hydraulic Schematic
Continued

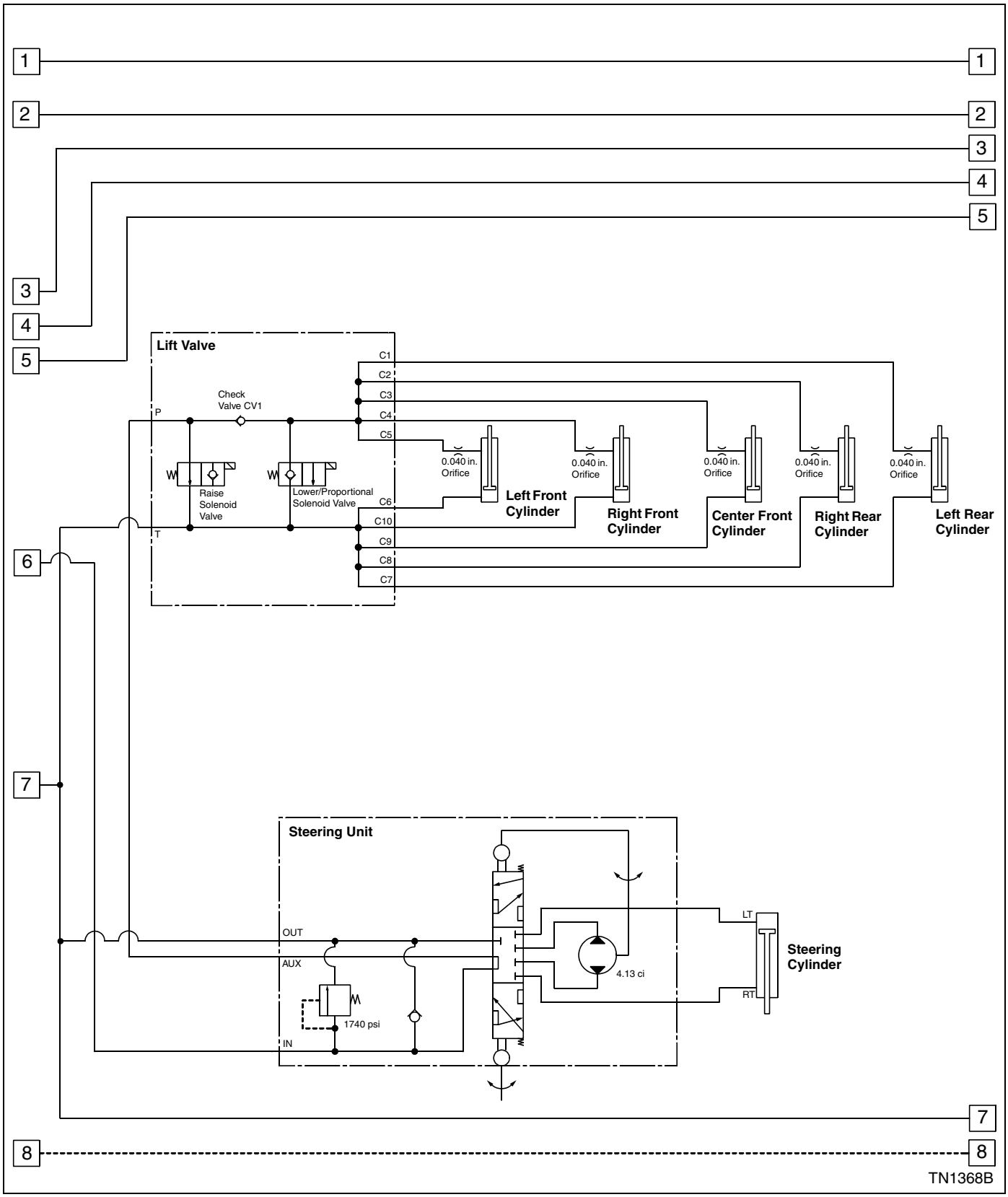


Figure 6-4

Hydraulic Schematic
Continued

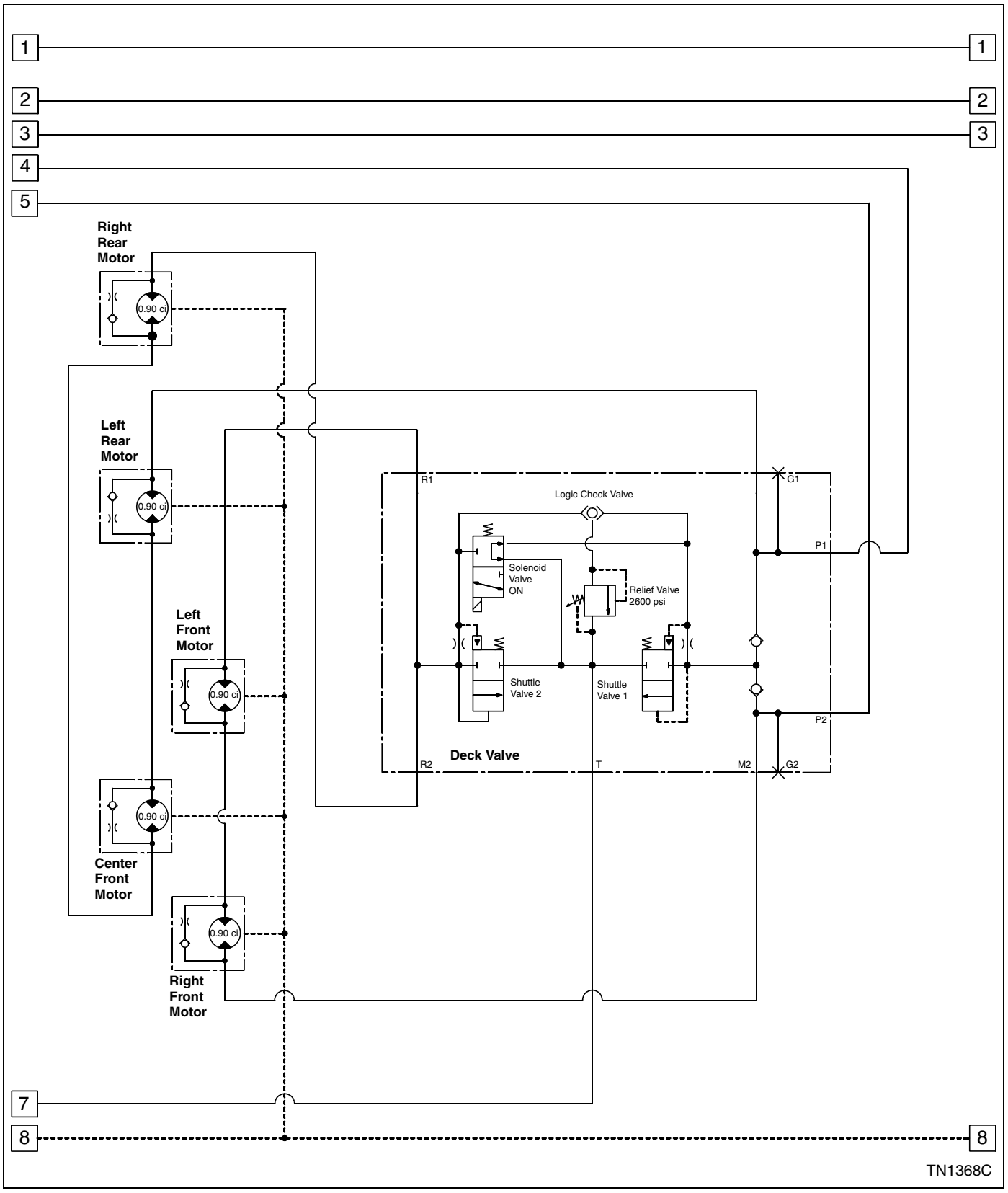


Figure 6-5

Hydraulic Schematic
Continued

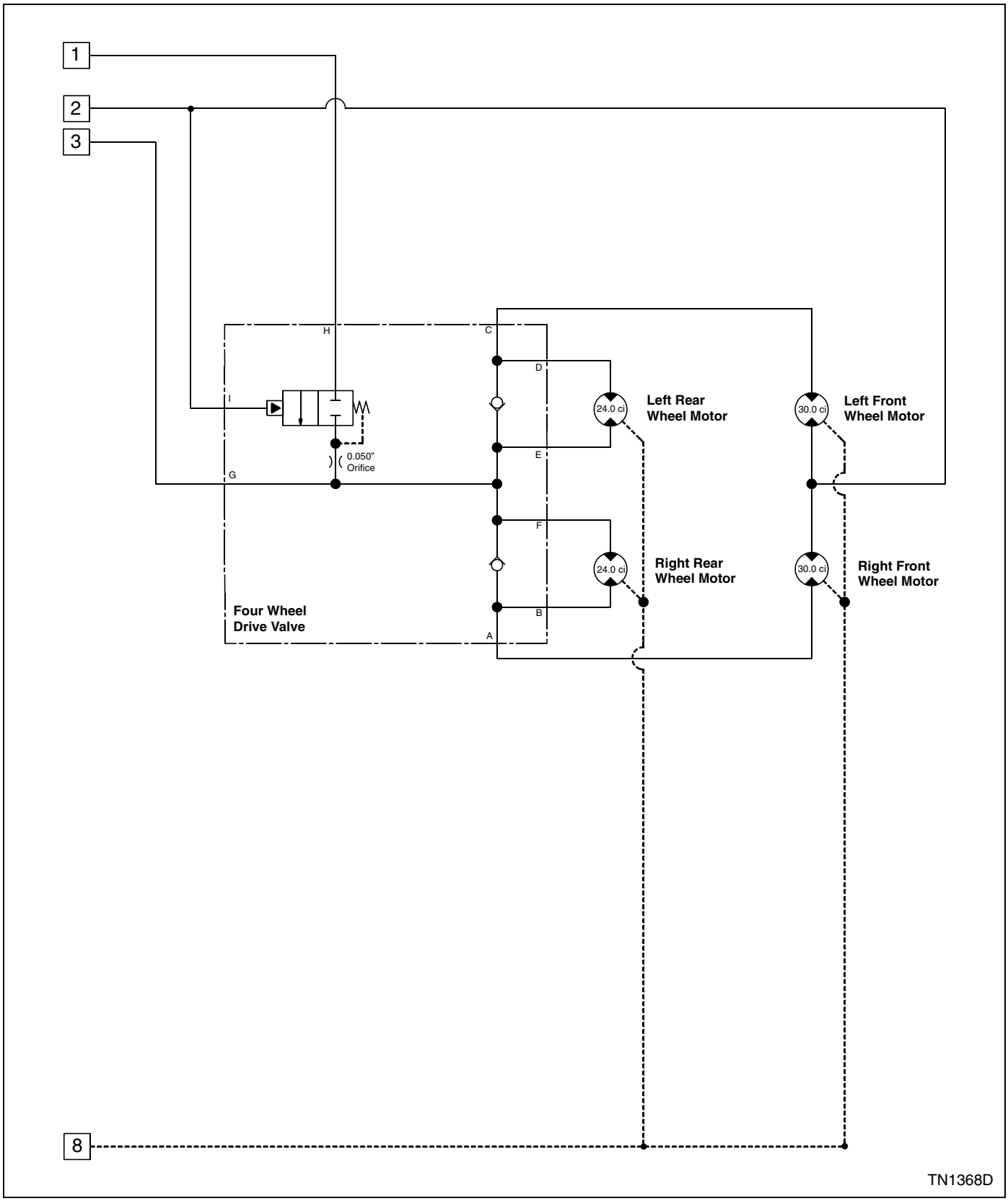


Figure 6-6

Theory of Operation and Diagnostic Information

Steering Circuit Schematic and Theory of Operation

See Figure 6-7.

System Conditions:

- Engine running
- Steering wheel turned to the right or left (left turn shown)

Hydraulic oil is drawn from the hydraulic oil tank by the steering section of the gear pump assembly. Before entering the gear pump assembly, the inlet oil is filtered by a 100-mesh screen to remove any debris. Operating-pressure oil is then routed to the IN port of the steering valve assembly, and oil is applied to the relief valve, check valve, and steering direction valve.

With the steering wheel in the neutral (straight ahead) position, the steering direction valve routes all of the operating-pressure oil out of the steering valve assembly through the AUX port, supplying operating-pressure oil to the lift valve assembly. If pressure within the lift system reaches 1740 psi (120 bar), the relief valve will open, dumping oil flow back to the hydraulic oil tank through the return filter and oil cooler. The relief valve will close once the lift system pressure drops below the relief valve setting.

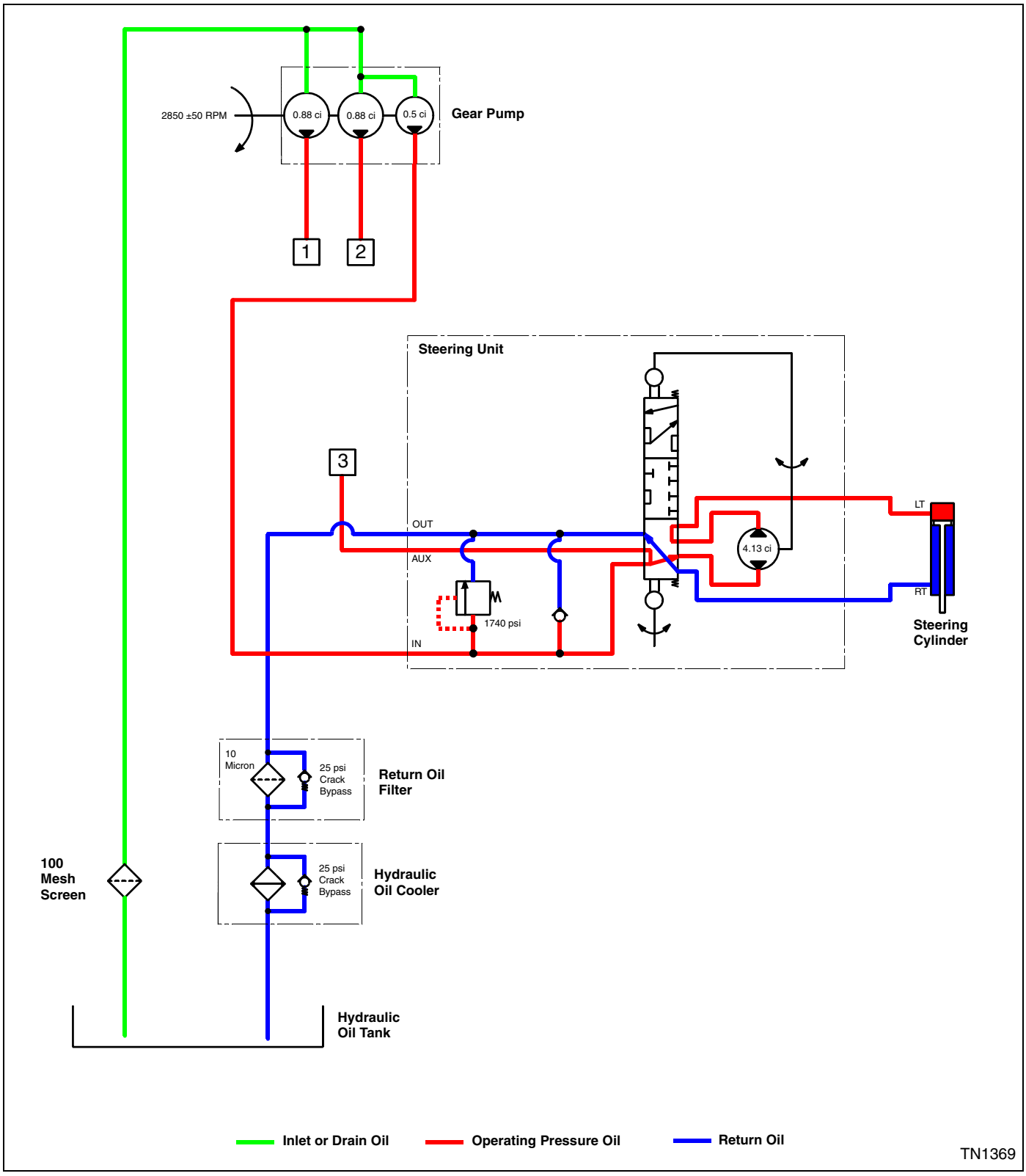
When the steering wheel is turned, the steering direction valve directs operating-pressure oil to one side of the steering cylinder, moving the piston and steering arms, turning the rear wheels.

Low-pressure (return) oil from the other side of the steering cylinder flows through the steering direction valve and exits the steering valve assembly at the OUT port. It then flows back to the hydraulic oil tank through the return filter and oil cooler. The return filter and oil cooler are equipped with crack bypass valves. If either of them becomes clogged and restricts oil flow, the valve(s) will open to allow oil to bypass the return filter (or oil cooler) to allow oil to flow to the hydraulic oil tank.

A portion of the operating-pressure oil flowing through the steering direction valve is directed to the lift valve to supply oil to the raise/lower circuit. (See “Raise Circuit Schematic and Theory of Operation” on page 6-12.) (See Lower Circuit Schematic and Theory of Operation on page 6-14.) The amount of oil directed to the raise/lower circuit will depend on the position of the steering wheel, as the steering circuit has priority. The most oil will flow to the raise/lower circuit when the steering wheel is in the neutral (straight ahead) position.

Steering Circuit Schematic

See Figure 6-7.



1 Operating-pressure Oil to Deck Valve (Port P1)
2 Operating-pressure Oil to Deck Valve (Port P2)
3 Operating-pressure Oil to Lift Valve (Port P)

Figure 6-7

Raise Circuit Schematic and Theory of Operation

See Figure 6-8.

System Conditions:

- Engine running
- Traction control switch in the OFF position
- Raise/lower joystick in the RAISE position

NOTES

- *See “Raise/Lower Circuit—Theory of Operation” on page 4-30 for the electrical operation of this circuit.*
- *All cylinders operate the same way; left rear cylinder shown.*

Operating-pressure oil is supplied to port “P” of the lift valve by the steering circuit. (See “Steering Circuit Schematic and Theory of Operation” on page 6-10.) With the raise solenoid valve energized, and the lowering/proportional valve de-energized, oil flows against the check valves of each valve, and exits the lift valve assembly through ports “C1” through “C5” in parallel to the rod end of each lift cylinder.

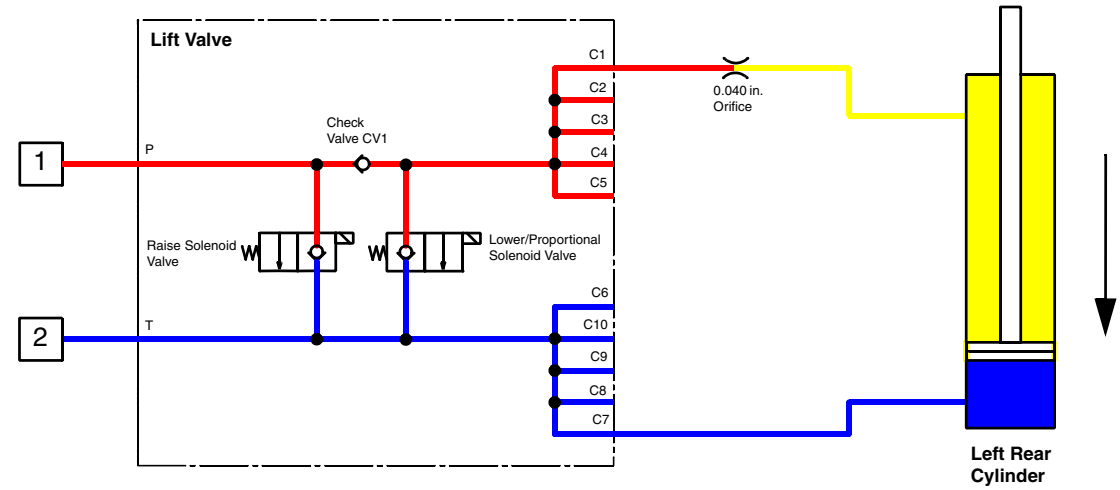
Oil passes through a 0.040 inch (1.016 mm) orifice at the rod end of each lift cylinder, and oil is applied to the back of the piston, causing the cylinder to retract, raising the cutting units.

Oil from the piston end of the lift cylinders flows back to the lift valve assembly through ports “C6” through “C10” in parallel. Oil exits the lift valve assembly through port “T,” and flows to the return filter, and oil cooler and back to the hydraulic oil tank.

If there is resistance to flow at the lift cylinders, causing oil pressure to rise above the steering relief valve setting of 1740 psi (120 bar), the steering relief valve will open. Oil flow will then be dumped back to the hydraulic oil tank through the return filter and oil cooler.

Raise Circuit Schematic

See Figure 6-8.



C1 = Left Rear Cylinder—Rod End
C2 = Right Rear Cylinder—Rod End
C3 = Center Front Cylinder—Rod End
C4 = Right Front Cylinder—Rod End
C5 = Left Front Cylinder—Rod End
C6 = Left Front Cylinder—Piston End
C7 = Left Rear Cylinder—Piston End
C8 = Right Rear Cylinder—Piston End
C9 = Center Font Cylinder—Piston End
C10 = Right Front Cylinder—Piston End

Operating Pressure Oil **Metered Oil** **Return Oil**

TN1372

1 Operating Pressure Oil from Steering Valve AUX Port 2 Return Oil to Oil Filter, Oil Cooler, and Hydraulic Oil Tank

Figure 6-8

6

Lower Circuit Schematic and Theory of Operation

See Figure 6-9.

System Conditions:

- Engine running
- Traction control switch in the OFF position
- Raise/lower joystick in the LOWER position

NOTES

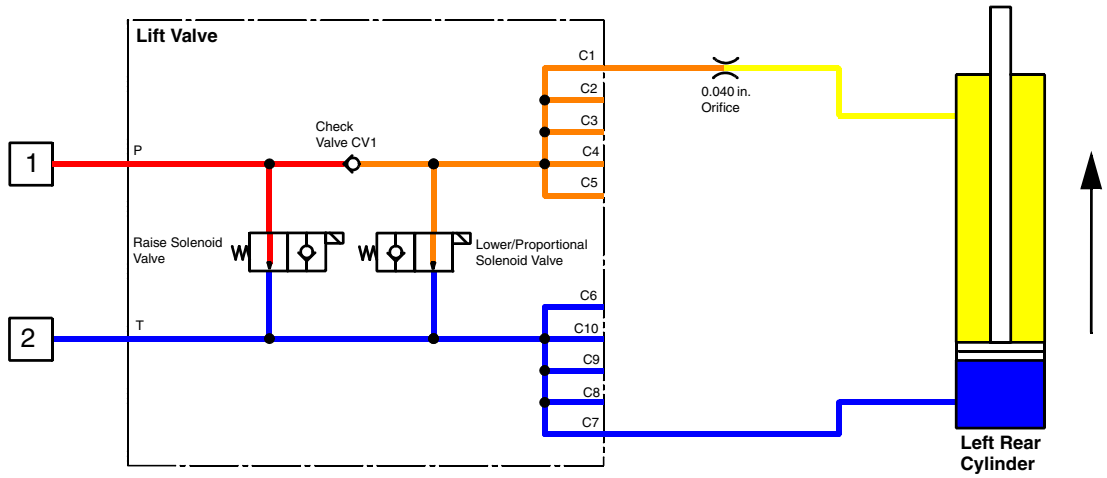
- *See “Raise/Lower Circuit—Theory of Operation” on page 4-30 for the electrical operation of this circuit.*
- *All cylinders operate the same way; left rear cylinder shown.*

Operating-pressure oil is supplied to port "P" of the lift valve assembly by the steering circuit. *(See “Steering Circuit Schematic and Theory of Operation” on page 6-10.)* With the raise solenoid valve de-energized, the operating-pressure oil flows through the valve, back to the return filter and oil cooler, and then back to the hydraulic oil tank.

Gravity pulls the cutting units down, pulling against the lift cylinders. Oil from the rod end of the lift cylinders flows through the 0.040 inch (1.016 mm) orifices in each cylinder, and back into the lift valve through ports “C1” through “C5” in parallel. The oil is applied against the check valve, closing the valve. Oil then flows through the energized lowering/proportional solenoid valve and back to the return filter, oil cooler, and hydraulic tank. A small amount of oil is also supplied to the piston end of the cylinder to compensate for the change in volume as the piston moves back.

Lower Circuit Schematic

See Figure 6-9.



C1 = Left Rear Cylinder—Rod End
C2 = Right Rear Cylinder—Rod End
C3 = Center Front Cylinder—Rod End
C4 = Right Front Cylinder—Rod End
C5 = Left Front Cylinder—Rod End
C6 = Left Front Cylinder—Piston End
C7 = Left Rear Cylinder—Piston End
C8 = Right Rear Cylinder—Piston End
C9 = Center Font Cylinder—Piston End
C10 = Right Front Cylinder—Piston End

Operating Pressure Oil **Charge-Pressure Oil** **Metered Oil** **Return Oil**

TN1371

1 Operating Pressure Oil from Steering Valve AUX Port 2 Return Oil to Oil Filter, Oil Cooler, and Hydraulic Oil Tank

Figure 6-9

6

Traction Control Circuit Schematic and Theory of Operation

See Figure 6-10.

System Conditions:

- Engine running
- Traction control switch on the ON position

NOTES

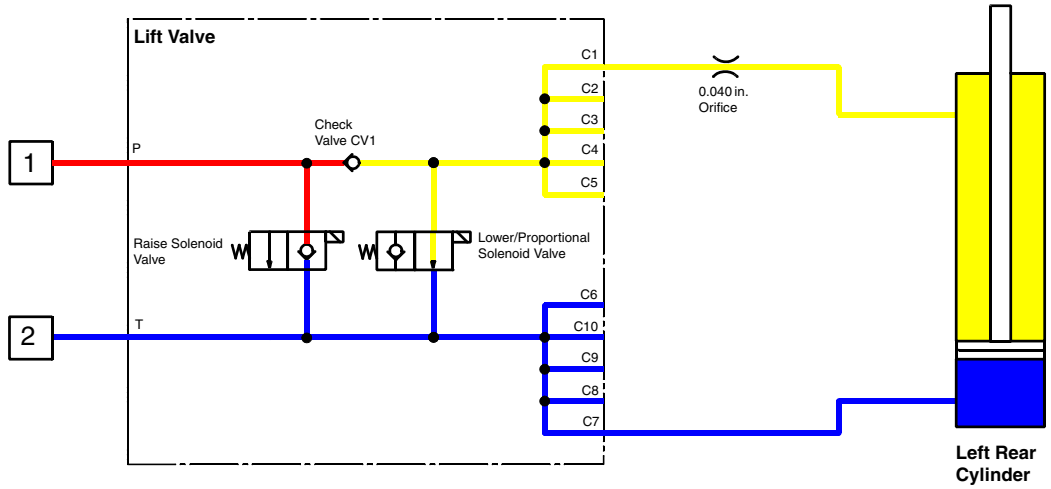
- *See “Traction Control Circuit—Theory of Operation” on page 4-36, for the electrical operation of this circuit.*
- *All cylinders operate the same way; left rear cylinder shown.*

The purpose of the traction control circuit is to allow the transfer of weight from the cutting units to the wheels to improve traction. This is done by applying slight upward pressure on the cutting units.

Operating-pressure oil is supplied to port “P” of the lift valve by the steering circuit. (See “Steering Circuit Schematic and Theory of Operation” on page 6-10.) When the traction control is activated (On), the controller activates the raise solenoid valve (On) and the lower/proportional solenoid valve (On). The controller pulses the electrical signal to the lowering proportional solenoid valve to meter the amount of oil pressure in ports “C1” through “C5.” The metered oil pressure is approximately 400 psi (27 bar) and is adjustable through the traction control calibration. If the traction control is improperly calibrated it can raise the decks off the ground. The oil pressure allowed to build up in the circuit allows the cutting units to transfer weight to the wheels improving traction.

Traction Control Circuit Schematic

See Figure 6-10.



C1 = Left Rear Cylinder—Rod End
C2 = Right Rear Cylinder—Rod End
C3 = Center Front Cylinder—Rod End
C4 = Right Front Cylinder—Rod End
C5 = Left Front Cylinder—Rod End
C6 = Left Front Cylinder—Piston End
C7 = Left Rear Cylinder—Piston End
C8 = Right Rear Cylinder—Piston End
C9 = Center Font Cylinder—Piston End
C10 = Right Front Cylinder—Piston End

Operating Pressure Oil **Metered Oil** **Return Oil**

TN1370

1 Operating Pressure Oil from Steering Valve AUX Port 2 Return Oil to Oil Filter, Oil Cooler, and Hydraulic Oil Tank

Figure 6-10

6

Mow Circuit Schematic and Theory of Operation

Mow Circuit (On) Theory of Operation

See Figure 6-11.

System Conditions:

- Engine running
- Cutting units lowered
- Mow switch in the ON position
- Park brake released

NOTE

See “Mow Circuit—Theory of Operation” on page 4-34 for the electrical operation of this circuit.

Hydraulic oil is drawn from the hydraulic oil tank by the gear pump assembly, sections 1 and 2. Before entering the gear pump assembly, the inlet oil is filtered by a 100-mesh screen to remove any debris.

Oil Supply—Right and Left Rear and Center Front Cutting Unit Motors

Operating-pressure oil from the gear pump (pump section 1) is supplied to the deck valve at port "P1." Oil then flows through port “M1” to the left rear, center front, and right rear cutting unit motors in series. Operating-pressure oil is also applied to check valve 1 in the deck valve. The three motor system has a higher working pressure than the two motor system, therefore check valve 1 opens and operating pressure oil is applied against check valve 2 keeping it closed. Oil also flows through an orifice to the shuttle valve 1 (pilot lines on both sides of the valve and supply to the valve). With oil pressure on the pilot lines on both sides of the valve, and spring bias on one side of the valve, the valve will remain closed, preventing oil flow. The orifice helps maintain equal pressure on either side of the shuttle valve. Oil is also supplied to the solenoid ON valve and logic check valve, seating the logic check valve against the return side of the system. With the solenoid ON valve energized, operating-pressure oil cannot flow through the valve. Oil pressure forces the logic check valve to open, allowing the flow of oil to the pilot line of the relief valve.

Oil Supply—Right and Left Front Cutting Unit Motors

Operating-pressure oil from the gear pump (pump section 2) is supplied to the deck valve at port “P2.” Oil then flows through port “M2” to the right front, and left front cutting unit motors. Operating-pressure oil is also applied to check valve 1 in the deck valve. The three motor system produces greater pressure than the two motor system. When check valve 1 opens, operating pressure is applied against check valve 2 keeping it closed. Oil also flows through an orifice to the shuttle valve 1 (pilot lines on both sides of the valve and supply to the valve). With oil pressure on the pilot lines on both sides of the valve, and spring pressure on one side of the valve, the valve will remain closed, preventing oil flow. The orifice helps maintain equal pressure on either side of the shuttle valve. Oil is also supplied to the solenoid ON valve and logic check valve, seating the logic check valve against the return side of the system. With the solenoid ON valve energized, operating-pressure oil cannot flow through the valve. Oil pressure forces the logic check valve to open, allowing the flow of oil to the pilot line of the relief valve.

System Relief

If there is resistance to flow at the cutting unit motors, causing oil pressure to rise above the relief valve setting of 2600 psi (179 bar), the relief valve will open. When the relief valve opens, oil flows through the orifice at shuttle valve 1, resulting in a pressure drop allowing shuttle valve one to shift permitting full pump flow to return to filter, cooler and tank.

Oil Return

Return oil from the cutting unit motors enters the deck valve through ports “R1” (right and left front cutting unit motors) and “R2” (right and left rear and center front cutting unit motors) and flows through the solenoid ON valve and shuttle valve 2. It then flows back to the return filter and oil cooler and back to the hydraulic oil tank.

The return filter and oil cooler are equipped with crack bypass valves. If either of them becomes clogged and restricts oil flow, the valve(s) will open to allow oil to bypass the return filter (or oil cooler) to allow oil to flow to the hydraulic oil tank.

Oil that leaks through the motors drains back to the hydraulic oil tank through the case drain hoses.

Mow Circuit (Off) Theory of Operation

See Figure 6-12.

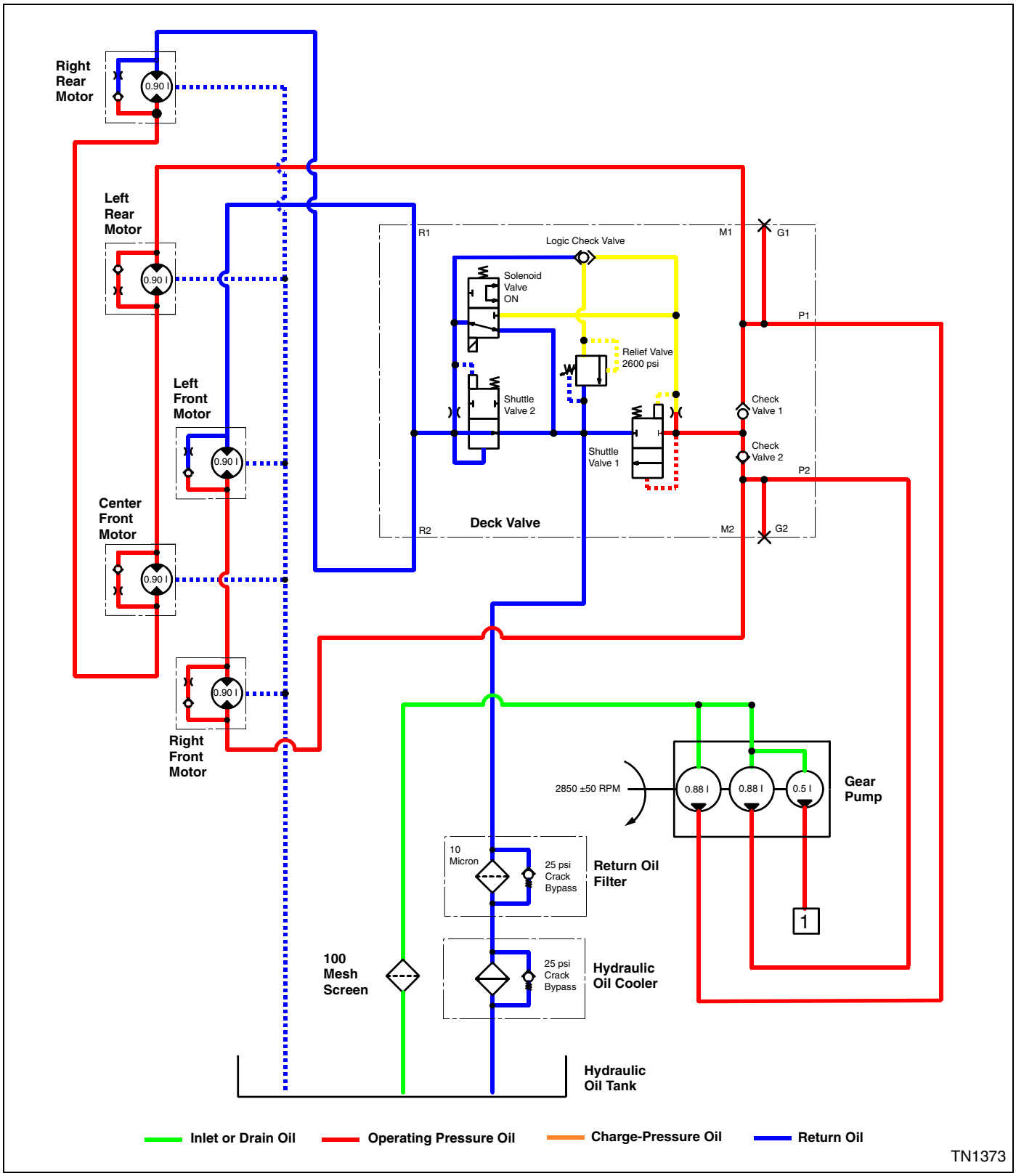
System Conditions:

- Engine running
- Cutting units lowered
- Mow switch in the OFF position
- Park brake released

Operating-pressure oil from the gear pump (pump section 1) is supplied to the deck valve at port “P1” and from (pump section 2) at deck valve port “P2.” Operating-pressure oil then flows to, and opens, check valves 1 and 2. Oil also flows to all system deck motors, pressurizing the system. With system operating-oil pressure equal in the system, spring biased shuttle valve 2 shifts to the closed position. With the solenoid valve in the OFF position, oil is forced to drain to the hydraulic tank, allowing the spring biased shuttle valve 1 to shift open, creating a direct path to drain oil.

Mow Circuit (On) Schematic

See Figure 6-11.



1 Operating Pressure Oil to Steering Circuit

Figure 6-11

Mow Circuit (Off) Schematic

See Figure 6-12.

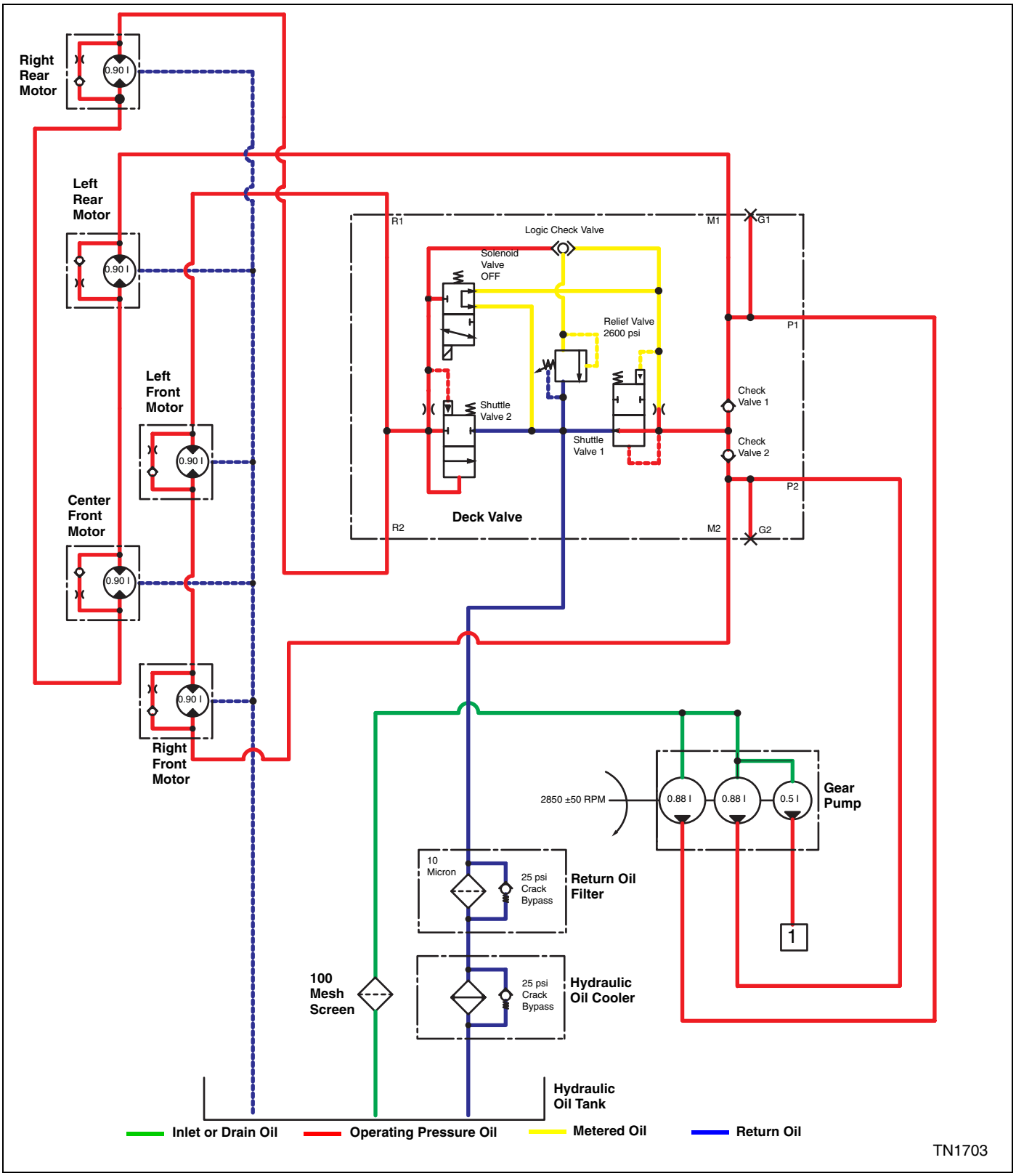


Figure 6-12

Field Test Procedures

Lift Cylinder Leakage Test

See Figures 6-13 and 6-14.

WARNING

The hydraulic system is under pressure, and the oil will be hot.

- **Always relieve pressure in the hydraulic system before performing service.**
- **Failure to follow appropriate safety precautions may result in death or serious injury.**

1. Start engine. Operate hydraulic system until oil temperature is at 120—150°F (49—65°C).
2. Raise cutting units.
3. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
4. Support all cutting unit lift arms.

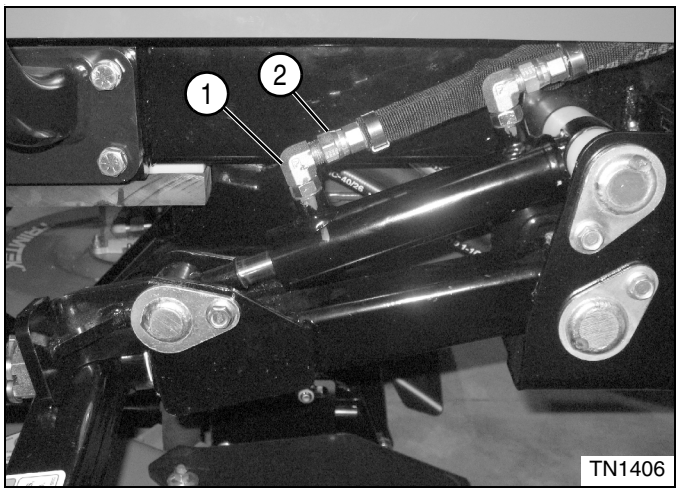


Figure 6-13

NOTE

Figure 6-12 shows left rear lift arm cylinder. Procedure is similar for right rear and front lift cylinders.

5. Disconnect hose (2) from lift cylinder rod end fitting (1).
6. Install plug in hose (2).
7. Install cap on lift cylinder fitting (1).
8. Remove support from cutting unit lift arm being tested.

   After 15 minutes, does cutting unit drift down?

   YES *Cylinder is bypassing oil. Replace lift cylinder. (See “Lift Cylinders” on page 6-49.)*

   NO *Repeat the test for all of the lift cylinders. If all cylinders pass test, the problem may be in the lift valve. Proceed to step 9.*
9. Support all cutting unit lift arms.
10. Connect hose (2) to lift cylinder fitting (1).
11. Start the engine and lower cutting units.
12. Stop the engine.

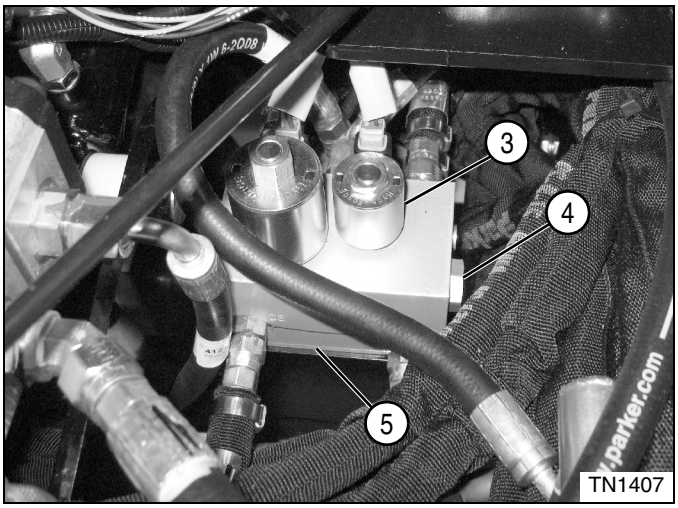


Figure 6-14

13. Remove the center floorboard.

IMPORTANT

Cutting units must be lowered to the ground.

14. Remove check valve (4) from the lift valve body (5).
15. Clean and inspect check valve for damage. Replace as necessary.
16. Start the engine and raise the cutting units.
17. Stop the engine.
18. If lift cylinders continue to drift down, start the engine and lower the cutting units.
19. Stop the engine.

IMPORTANT

Cutting units must be lowered to the ground.

20. Remove lower/proportional solenoid valve (3) from lift valve body (5).
21. Clean and inspect lower/proportional solenoid valve for damage. Replace as necessary. (See “Solenoid Test” on page 4-63.)

Power Steering Circuit Test

The purpose of this test is to determine if the steering cylinder and the steering valve are operating properly.

NOTE

Before performing this test, check the steering system for mechanical binding or damage that may affect the steering.

1. Operate the machine until hydraulic oil reaches operating temperature, 120—150°F (49—65°C).
2. With the engine running, turn the steering wheel all the way to the right, and then all the way to the left.

   Does the steering wheel continue to turn after full left or right movement of the steering cylinder?

   YES *Proceed to step 3.*

   NO *Steering system is not faulty.*
3. Stop the engine and remove both hydraulic hoses from the steering cylinder; plug the hoses and cap the cylinder ports.
4. Start the engine and turn the steering wheel all the way to the right and then all the way to the left. Only a little movement should be evident.

   Is the steering wheel hard to turn or does not turn?

   YES *Steering cylinder is faulty; repair or replace as needed. (See "Steering Cylinder" on page 7-19.)*

   With steady pressure in one direction, does steering wheel make one complete revolution in 30 seconds?

   YES *Steering valve is faulty; repair or replace as needed. (See "Steering Valve" on page 7-7.)*

Cutting Unit System Test

The cutting unit system consists of two circuits: the front cutting unit circuit and the rear cutting unit circuit. The front cutting unit circuit consists of the front cutting unit pump, deck valve, right front cutting unit motor, and left front cutting unit motor. The rear cutting unit circuit consists of the rear cutting unit pump, deck valve, left rear cutting unit motor, center cutting unit motor, and right rear cutting unit motor. This test determines if one of the cutting unit motors is faulty. An instrument test must be performed to isolate the performance of the cutting unit pumps and deck valve.

NOTES

- *Perform test on only one cutting unit motor at a time.*
- *The case drain on a hydraulic motor is used to return lubrication or bypassed hydraulic oil back to the hydraulic tank.*

1. Operate the machine until hydraulic oil reaches operating temperature, 120—150°F (49—65°C).
2. Stop the engine and remove the key.
3. Bypass the seat switch.
4. Remove the case drain hose from the cutting unit motor. Immediately plug the hose.
5. Position a drain pan with a minimum capacity of 1 gallon (3.8 L) near the cutting unit motor.
6. Install a separate hose on the case drain fitting and place the free end in the container. Secure the hose to prevent spills.

WARNING

Safely block cutting unit from rotating using a suitable device or tool. Failure to follow appropriate safety precaution may result in death or serious injury.

7. Install suitable blocking device or tool in cutting unit, preventing cutting unit from turning.
8. Set the park brake and start the engine.
9. Disconnect park brake switch. (See "Park Brake Proximity Switch" on page 4-74.)
10. Place the mow switch in the ON position for 15 seconds.
11. Stop the engine and remove the ignition key.
12. Measure the amount of oil that flowed from the case drain. The amount x 4 = amount per minute.

    Is the oil captured from the case drain within a half pint per minute?

    YES *The motor shaft and/or bearings are not faulty; proceed with an instrument test. (See "Instrument Test Procedure" on page 6-23.)*

    Is the oil captured from the case drain more than 1 pint per minute?

    YES *The motor may be faulty; repair or replace as needed. (See "Cutting Unit Motors" on page 6-43.)*
13. Disconnect and remove test equipment. Install all hoses, fittings, and components as noted prior to removal.

Instrument Test Procedure

Instrument Test Overview

The following tests are specifically designed to approach hydraulic testing on a system level. Each component within the system represents a portion of the total system leakage. An internal leakage percentage for each component will be calculated and recorded, enabling the technician to view the system performance issue more completely. The test results will help the technician to determine which repairs will best remedy the performance issue experienced by the machine user.

The internal leakage percentage ranges are as follows:

0—10% = Good

11—20% = Marginal

21% and beyond = Bad

Example: Cutting Unit System Performance Complaint

The machine operator reports the mower is not cutting correctly.

Troubleshooting must first be performed to rule out a cutting unit adjustment issue. Once the issue is known to be component related, the entire cutting unit system is tested as outlined. The calculated system leakage is 35%; a result which requires the testing of individual components. This result can also be interpreted as the system is 65% efficient.

The remaining components in question are as follows: rear cutting unit pump, deck valve, left rear cutting unit motor, center cutting unit motor, and right rear cutting unit motor. Following the procedures as outlined, test each individual component, then calculate and record leakage percentages.

The results from this test reveal leakage of 5% in the rear cutting unit pump, 10.5% in the deck valve, 20% in the left rear cutting unit motor, 5.6% in the center cutting unit motor, and 4.4% in the right rear cutting unit motor. Although all the components lend to the overall circuit leakage, only the left rear cutting unit motor, which is at the extreme end of the marginal range, would be considered for repair/replacement.

Formulas:

Cutting Unit Motor and Deck Valve

Loaded Flow from previous component – Loaded Flow from current component / Loaded Flow from previous component x 100 = Leak Percentage

Circuit and Rear Cutting Unit Pump

No Load Flow – Loaded Flow / No Load Flow x 100 = Leak Percentage

Calculations:

Circuit Test

No Load Flow = 10 gpm

Loaded Flow = 6.5 gpm

10 – 6.5 / 10 x 100 = Total Circuit Leakage 35%

Rear Cutting Unit Pump Test

No Load Flow = 10 gpm

Loaded Flow = 9.5 gpm

10 – 9.5 / 10 x 100 = Rear Cutting Unit Pump Leakage 5%

Deck Valve Test

Loaded Flow from rear cutting unit pump test = 9.5 gpm

Loaded Flow from deck valve test = 9 gpm

10 – 9 / 9.5 x 100 = Deck Valve Leakage 10.5%

Left Rear Cutting Unit Motor Test

Loaded Flow from deck valve test = 9 gpm

Loaded Flow from left rear cutting unit motor test = 7.2 gpm

9 – 7.2 / 9 x 100 = Left Rear Cutting Unit Motor Leakage 20%

Center Cutting Unit Motor Test

Loaded Flow from left rear cutting unit motor test = 7.2 gpm

Loaded Flow from center cutting unit motor test = 6.8 gpm

7.2 – 6.8 / 7.2 x 100 = Center Cutting Unit Motor Leakage 5.6%

Right Rear Cutting Unit Motor Test

Loaded Flow from center cutting unit motor test = 6.8 gpm

Loaded Flow from right rear cutting unit motor test = 6.5 gpm

6.8 – 6.5 / 6.8 x 100 = Right Rear Cutting Unit Motor Leakage = 4.4%

Front Cutting Units Circuit

See Figures 6-15 and 6-16.

IMPORTANT

- **This test works together with the front cutting units motors test to isolate a problem with the front cutting unit circuit.**
- **Performing this test will isolate the front cutting units pump, deck valve, and right front cutting unit motor from the rest of the front cutting units circuit.**

⚠ WARNING

The hydraulic system is under pressure, and the oil will be hot.

- **Always relieve pressure in the hydraulic system before performing service.**
- **Failure to follow appropriate safety precautions may result in death or serious injury.**

Required Tools and Materials
• Flow Meter
• -8 ORFS Test Hose 3000 psi (207 bar)
• -8 ORFS Tee Fitting
• Blocking Device or Tool

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove the center floorboard.

IMPORTANT

Depending on the machine model number and production date, the possibility exists that the hoses connected to the center and rear sections of the gear pump could be reversed. This design change does not affect the operation of the mower, but will affect the outcome of this test as outlined. Please confirm that the hose connected to the center section of the gear pump is connected to deck valve port “P2”. Please see “Hydraulic Schematic” on page 6-6 for additional information.

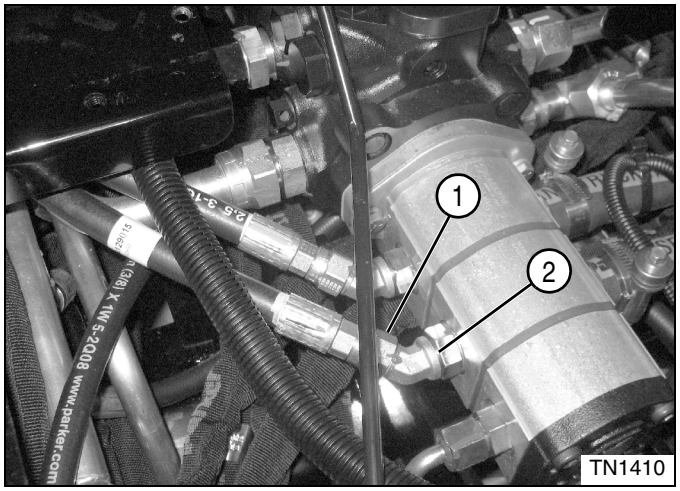


Figure 6-15

3. Disconnect hose (1) from fitting (2).

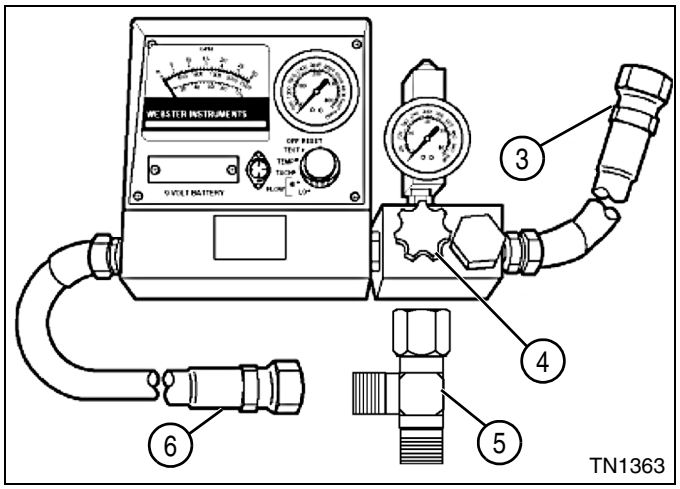


Figure 6-16

4. Install tee fitting (5) to fitting (2).
5. Connect test hose (6) of flow meter inlet and hose (1) to tee fitting (5).

NOTE

Make sure hose end is under oil level in hydraulic tank to prevent aeration of oil.

6. Connect flow meter outlet hose (3) to the hydraulic tank.

WARNING

Safely block cutting unit from rotating using a suitable device or tool. Failure to follow appropriate safety precaution may result in death or serious injury.

7. Install suitable blocking device or tool in right front cutting unit, preventing cutting unit from turning. Open flow meter valve (4) completely.
8. Bypass seat switch.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

9. Start engine and run at full throttle (2850 rpm ± 50).
10. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve (4) until a reading of 1300 psi (90 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.
11. Disconnect park brake switch.
12. Engage cutting unit switch.
13. Read and record the front cutting units pump no load flow.
14. Slowly close flow meter valve (4) until pressure reaches 1950 psi (134 bar). Read and record the front cutting units pump loaded flow.
15. Open flow meter valve (4) and stop engine.
16. Calculate front cutting units circuit leakage. (Step 13 – Step 14 / Step 13 x 100 = Leak Percentage)

Is front cutting units circuit leakage 10% or less?

YES *The front cutting units circuit is good. Proceed to "Front Cutting Units Motors Test" on page 6-28.*

NO *Proceed to next question.*

Is front cutting units circuit leakage 11% to 20%?

YES *The front cutting units circuit is marginal. Additional testing is required.*

NO *Proceed to next question.*

Is front cutting units circuit leakage 21% or more?

YES *Test individual components in front cutting units circuit for leakage.*

17. Disconnect and remove test equipment. Remove blocking device or tool from cutting unit. Install all hoses and fittings as noted prior to removal.
18. Install and connect all components as noted prior to test.
19. Check hydraulic oil level. Add oil as needed. (Refer to "Safety, Operation, and Maintenance Manual" for correct oil specifications.)

Front Cutting Units Pump Test

See Figures 6-17 and 6-18.

WARNING

The hydraulic system is under pressure, and the oil will be hot.

- **Always relieve pressure in the hydraulic system before performing service.**
- **Failure to follow appropriate safety precautions may result in death or serious injury.**

Required Tools and Materials
• Flow Meter
• -8 ORFS Test Hose 3000 psi (207 bar)
• -8 ORFS Tee Fitting
• -8 ORFS Blocking Disk

1. Park the mower safely. (See "Park Mower Safely" on page 1-5.)
2. Before performing this test, perform front cutting units circuit test leaving flow meter connected as outlined.

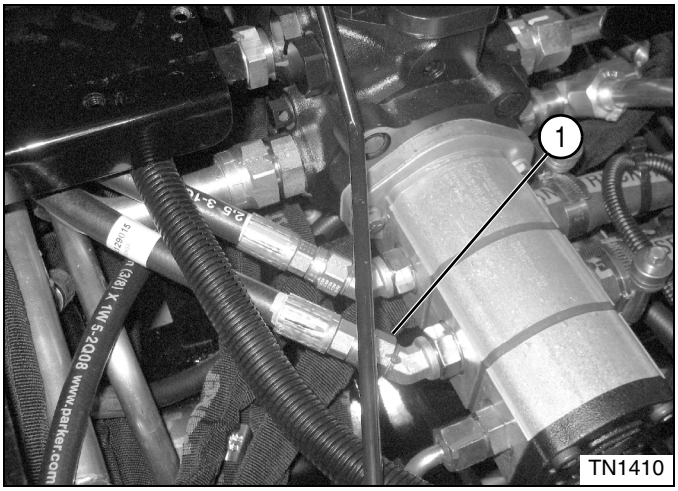


Figure 6-17

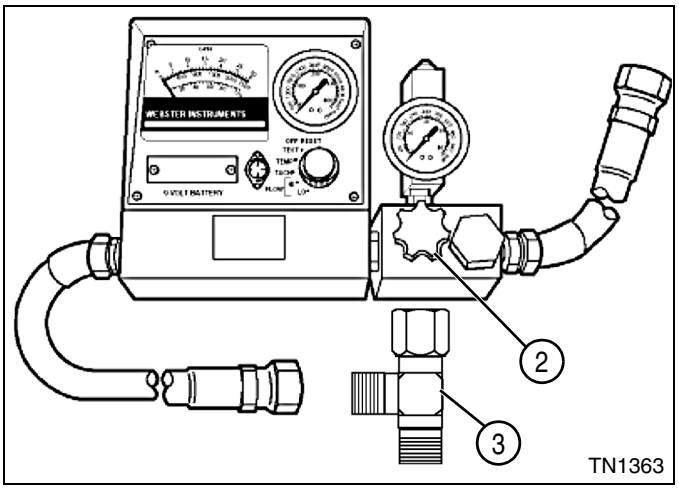


Figure 6-18

3. Install blocking disk between hose (1) and tee fitting (3).
4. Open flow meter valve (2) completely.
5. Bypass seat switch.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

6. Start engine and run at full throttle (2850 rpm ± 50).
7. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve until a reading of 1300 psi (90 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.

⚠ CAUTION

Do not exceed 1950 psi (134 bar) when testing pump or equipment damage may occur.

8. Slowly close flow meter valve until pressure reaches 1950 psi (134 bar). Read and record the front cutting units pump loaded flow.
9. Stop engine.
10. Calculate front cutting units pump leakage. (Step 14 of previous test – Step 8 / Step 14 of previous test x 100 = Leak Percentage)

    Is front cutting units pump leakage 10% or less?

    YES *The front cutting units pump is good. Proceed to next test.*

    NO *Proceed to next question.*

    Is front cutting units pump leakage 11% to 20%?

    YES *The front cutting units pump is marginal. Additional testing is required.*

    NO *Proceed to next question.*

    Is front cutting units pump leakage 21% or more?

    YES *Repair or replace front cutting units pump. (See “Gear Pump” on page 6-41.)*
11. Disconnect and remove test equipment. Install all hoses and fittings as noted prior to removal.
12. Install and connect all components as noted prior to test.
13. Check hydraulic oil level. Add oil as needed. (Refer to “Safety, Operation, and Maintenance Manual” for correct oil specifications.)

Front Cutting Units Circuit Valve Tests

See Figures 6-19 and 6-20.

⚠ WARNING

The hydraulic system is under pressure, and the oil will be hot.

- **Always relieve pressure in the hydraulic system before performing service.**
- **Failure to follow appropriate safety precautions may result in death or serious injury.**

Required Tools and Materials
• Flow Meter • -8 ORFS Test Hose 3000 psi (207 bar) • -8 ORFS Tee Fitting • -10 ORFS Blocking Disk

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Before performing this test, perform front cutting units circuit test, leaving flow meter connected as outlined.

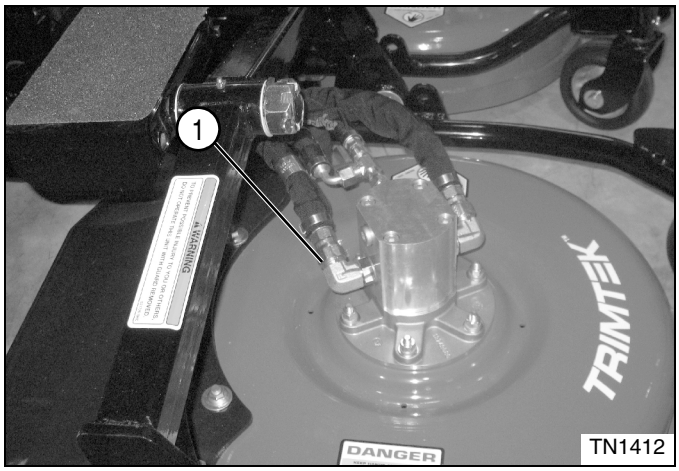


Figure 6-19

3. Install blocking disk at fitting (1) on right front cutting unit motor, blocking oil flow from entering right front cutting unit motor.

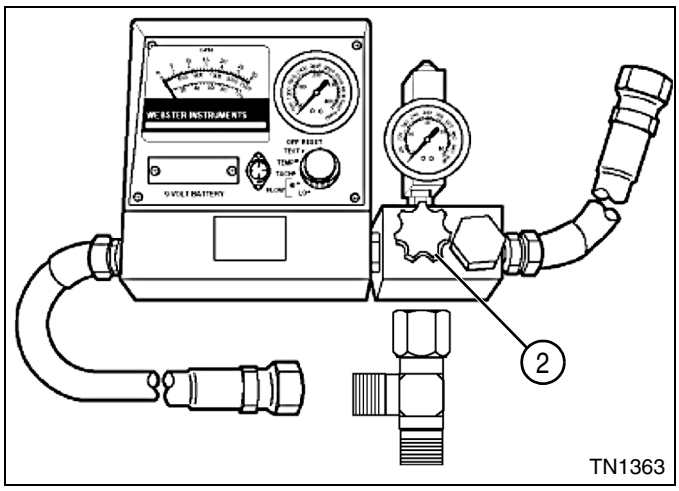


Figure 6-20

4. Open flow meter valve (2) completely.
5. Bypass seat switch.

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

6. Start engine and run at full throttle (2850 rpm ± 50).
7. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve (2) until a reading of 1300 psi (90 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.
8. Disconnect park brake switch.
9. Engage cutting unit switch.
10. Slowly close flow meter valve (2) until pressure reaches 1950 psi (134 bar). Read and record the front cutting units pump loaded flow.
11. Calculate front cutting units circuit valve leakage. (Step 8 of previous test – Step 10 / Step 8 of previous test x 100 = Leak Percentage)

    Is front cutting units circuit valve leakage 10% or less?

    YES *The front cutting units circuit valve is good. Proceed to step 12.*

    NO *Proceed to next question.*

    Is front cutting units circuit valve leakage 11% to 20%?

    YES *The front cutting units circuit valve is marginal. Additional testing is required.*

    NO *Proceed to next question.*

    Is front cutting units circuit valve leakage 21% or more?

    YES *Repair or replace deck valve. (See "Deck Valve" on page 6-45.)*

⚠ CAUTION

Do not exceed 2650 psi (183 bar) when testing system relief valve or equipment damage may occur.

12. Continue to close flow meter valve (2) until zero flow is obtained. Record cutting unit system relief valve pressure.
13. Open flow meter valve (2) and stop engine.

    Is cutting unit system relief valve pressure 2600 psi (179 bar)?

    YES *Cutting unit system relief valve is good. Proceed to step 14.*

    NO *Adjust cutting unit system relief pressure. (See "Adjust Cutting Unit System Relief Valve Pressure" on page 6-28.)*

14. Disconnect and remove test equipment. Install all hoses and fittings as noted prior to removal.
15. Install and connect all components as noted prior to test.
16. Check hydraulic oil level. Add oil as needed. (Refer to "Safety, Operation, and Maintenance Manual" for correct oil specifications.)

Adjust Cutting Unit System Relief Valve Pressure

See Figure 6-21.

WARNING

The hydraulic system is under pressure, and the oil will be hot.

- **Always relieve pressure in the hydraulic system before performing service.**
- **Failure to follow appropriate safety precautions may result in death or serious injury.**

Required Tools and Materials
• Flow Meter • -8 ORFS Test Hose 3000 psi (207 bar) • -8 ORFS Tee Fitting • -10 ORFS Blocking Disk

NOTE

This adjustment should be done in conjunction with front cutting units circuit valve tests.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Perform front cutting units circuit valve test. (See “Front Cutting Units Circuit Valve Tests” on page 6-26.)

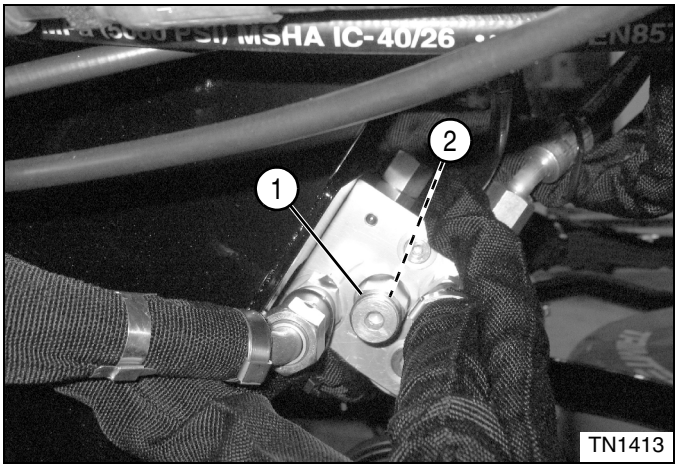


Figure 6-21

3. Remove cap (1).
4. Rotate screw (2) to adjust the relief valve pressure setting.
   - To increase the pressure setting: Turn the screw in (clockwise).
   - To decrease the pressure setting: Turn the screw out (counterclockwise).
5. Install cap (1).

   Could relief valve be adjusted to 2600 psi (179 bar)?

   YES *Cutting unit system relief valve is good. Proceed to step 6.*

   NO *Repair or replace cutting unit system relief valve. (See “Deck Valve” on page 6-45.)*
6. Disconnect and remove test equipment. Install all hoses and fittings as noted prior to removal.
7. Install and connect all components as noted prior to adjustment.
8. Check hydraulic oil level. Add oil as needed. (Refer to “Safety, Operation, and Maintenance Manual” for correct oil specifications.)

Front Cutting Units Motors Test

See Figure 6-22.

IMPORTANT

- **This test works together with the front cutting units circuit test to isolate a problem with the front cutting units circuit.**
- **Performing this test will isolate the front cutting unit motors from the rest of the front cutting units circuit.**

WARNING

The hydraulic system is under pressure, and the oil will be hot.

- **Always relieve pressure in the hydraulic system before performing service.**
- **Failure to follow appropriate safety precautions may result in death or serious injury.**

Required Tools and Materials
• Flow Meter • -8 ORFS Test Hose 3000 psi (207 bar) • -8 ORFS Tee Fitting • Blocking Device or Tool

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Before performing this test, perform front cutting units circuit test, leaving flow meter connected as outlined
3. Bypass seat switch.

IMPORTANT

- **If performing this test after performing front cutting units circuit test and test proved front cutting units pump, deck valve, and right front cutting unit motor good, proceed to step 14.**
- **If performing this test to determine which component in system is at fault (right front cutting unit motor or left front cutting unit motor) continue to step 4.**

WARNING

Safely block cutting unit from rotating using a suitable device or tool. Failure to follow appropriate safety precaution may result in death or serious injury.

4. Install suitable blocking device or tool in right front cutting unit, preventing cutting unit from turning.

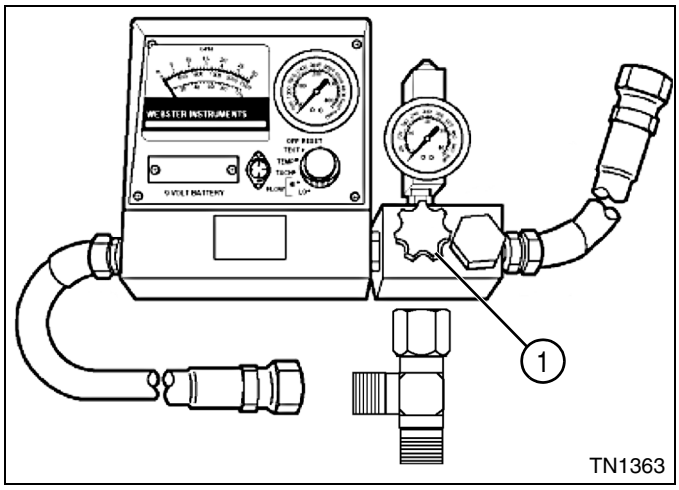


Figure 6-22

5. Open flow meter valve (1) completely.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

6. Start engine and run at full throttle (2850 rpm ± 50).
7. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve (1) until a reading of 1300 psi (90 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.
8. Disconnect park brake switch.
9. Engage cutting unit switch.
10. Slowly close flow meter valve (1) until pressure reaches 1950 psi (134 bar). Read and record the right front cutting unit motor loaded flow.
11. Open flow meter valve (1) and stop engine.
12. Calculate right front cutting unit motor leakage. (Step 10 of front cutting units circuit valve tests – Step 10 / Step 10 of front cutting units circuit valve tests x 100 = Leak Percentage)

    Is right front cutting unit motor leakage 10% or less?

    YES *The right front cutting unit motor is good. Proceed to step 13.*

    NO *Proceed to next question.*

    Is right front cutting unit motor leakage 11% to 20%?

    YES *The right front cutting unit motor is marginal. Additional testing is required.*

    NO *Proceed to next question.*

    Is right front cutting unit motor leakage 21% or more?

    YES *Repair or replace right front cutting unit motor. (See “Cutting Unit Motors” on page 6-43.)*
13. Remove device or tool from right front cutting unit.

WARNING

Safely block cutting unit from rotating using a suitable device or tool. Failure to follow appropriate safety precaution may result in death or serious injury.

14. Install suitable blocking device or tool in left front cutting unit, preventing cutting unit from turning.
15. Open flow meter valve (3) completely.
16. Connect park brake switch.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

17. Start engine and run at full throttle (2850 rpm ± 50).
18. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve (3) until a reading of 1300 psi (90 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.
19. Disconnect park brake switch.
20. Engage cutting unit switch.
21. Slowly close flow meter valve (3) until pressure reaches 1950 psi (134 bar). Read and record the left cutting unit motor loaded flow.
22. Open flow meter valve (3) and stop engine.

23. Calculate left front cutting unit motor leakage. (Step 10 – Step 21 / Step 10 x 100 = Leak Percentage)

    Is left front cutting unit motor leakage 10% or less?

    YES *The left front cutting unit motor is good. Proceed to step 24.*

    NO *Proceed to next question.*

    Is left front cutting unit motor leakage 11% to 20%?

    YES *The left front cutting unit motor is marginal. Proceed to step 24.*

    NO *Proceed to next question.*

    Is left front cutting unit motor leakage 21% or more?

    YES *Repair or replace left front cutting unit motor. (See "Cutting Unit Motors" on page 6-43.)*

24. Remove device or tool from left front cutting unit.
25. Disconnect and remove test equipment. Install all hoses and fittings as noted prior to removal.
26. Install and connect all components as noted prior to test.
27. Check hydraulic oil level. Add oil as needed. (Refer to "Safety, Operation, and Maintenance Manual" for correct oil specifications.)

Rear Cutting Units Circuit Test

See Figures 6-23 and 6-24.

IMPORTANT

- **This test works together with the rear cutting units motors test to isolate a problem with the rear cutting units circuit.**
- **Performing this test will isolate the rear cutting units pump, deck valve, and left rear cutting unit motor from the rest of the rear cutting units circuit.**

WARNING

The hydraulic system is under pressure, and the oil will be hot.

- **Always relieve pressure in the hydraulic system before performing service.**
- **Failure to follow appropriate safety precautions may result in death or serious injury.**

Required Tools and Materials
• Flow Meter • -8 ORFS Test Hose 3000 psi (207 bar) • -8 ORFS Tee Fitting • Blocking Device or Tool

1. Park the mower safely. (See "Park Mower Safely" on page 1-5.)
2. Remove the center floorboard.

IMPORTANT

Depending on the machine model number and production date, the possibility exists that the hoses connected to the center and rear sections of the gear pump could be reversed. This design change does not affect the operation of the mower, but will affect the outcome of this test as outlined. Please confirm that the hose connected to the center section of the gear pump is connected to deck valve port "P2". Please see "Hydraulic Schematic" on page 6-6 for additional information.

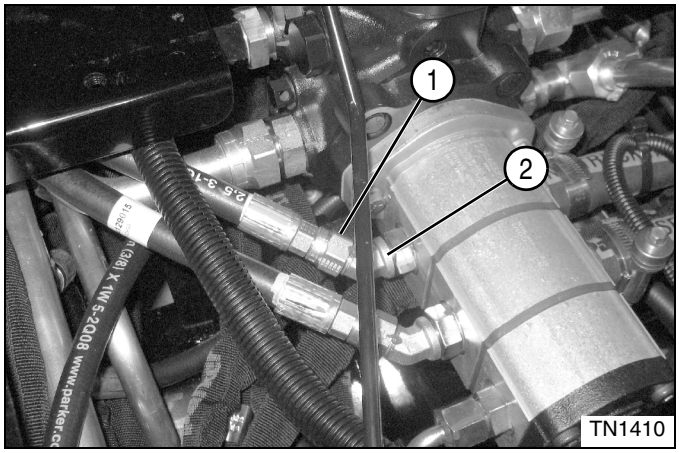


Figure 6-23

3. Disconnect hose (1) from fitting (2).

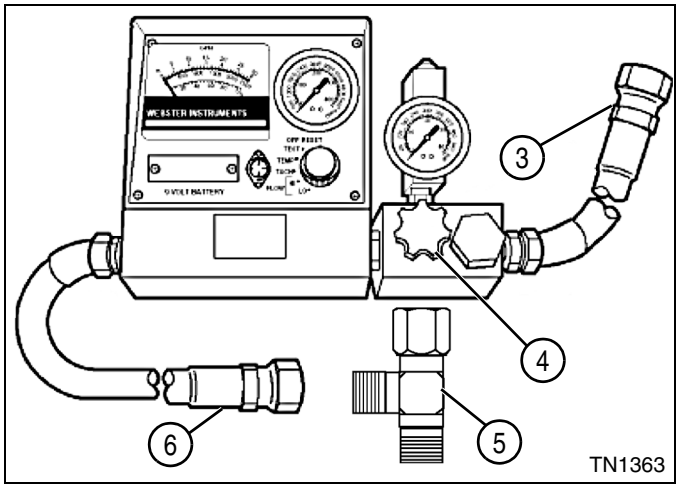


Figure 6-24

4. Install tee fitting (5) to fitting (2).
5. Connect test hose (6) of flow meter inlet and hose (1) to tee fitting (5).

NOTE

Make sure hose end is under oil level in hydraulic tank to prevent aeration of oil.

6. Connect flow meter outlet hose (3) to the hydraulic tank.

WARNING

Safely block cutting unit from rotating using a suitable device or tool. Failure to follow appropriate safety precaution may result in death or serious injury.

7. Install suitable blocking device or tool in left rear cutting unit, preventing cutting unit from turning. Open flow meter valve (4) completely.
8. Bypass seat switch.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

9. Start engine and run at full throttle (2850 rpm ± 50).
10. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve (4) until a reading of 1300 psi (90 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.
11. Disconnect park brake switch.
12. Engage cutting unit switch.
13. Read and record the rear cutting units pump no load flow.
14. Slowly close flow meter valve (4) until pressure reaches 1950 psi (134 bar). Read and record the rear cutting units pump loaded flow.
15. Open flow meter valve (4) and stop engine.
16. Calculate rear cutting units circuit leakage. (Step 13 – Step 14 / Step 13 x 100 = Leak Percentage)

    Is rear cutting units circuit leakage 10% or less?

    YES *The rear cutting units circuit is good. Proceed to* "Rear Cutting Units Motors Test" on page 6-34.

    NO *Proceed to next question.*

    Is rear cutting units circuit leakage 11% to 20%?

    YES *The rear cutting units circuit is marginal. Additional testing is required.*

    NO *Proceed to next question.*

    Is rear cutting units circuit leakage 21% or more?

    YES *Test individual components in rear cutting units circuit for leakage.*

17. Disconnect and remove test equipment. Remove blocking device or tool from cutting unit. Install all hoses and fittings as noted prior to removal.

18. Install and connect all components as noted prior to test.
19. Check hydraulic oil level. Add oil as needed. (Refer to “Safety, Operation, and Maintenance Manual” for correct oil specifications.)

Rear Cutting Units Pump Test

See Figures 6-25 and 6-26.

WARNING

The hydraulic system is under pressure, and the oil will be hot.

- **Always relieve pressure in the hydraulic system before performing service.**
- **Failure to follow appropriate safety precautions may result in death or serious injury.**

Required Tools and Materials
• Flow Meter
• -8 ORFS Test Hose 3000 psi (207 bar)
• -8 ORFS Tee Fitting
• -8 ORFS Blocking Disk

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Before performing this test, perform rear cutting units circuit test, leaving flow meter connected as outlined.

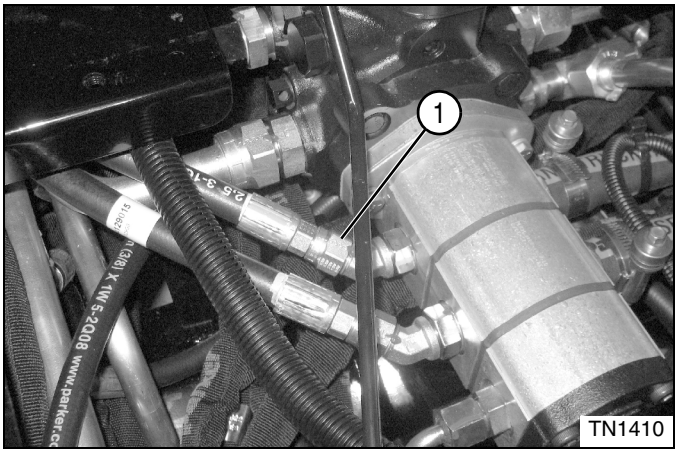


Figure 6-25

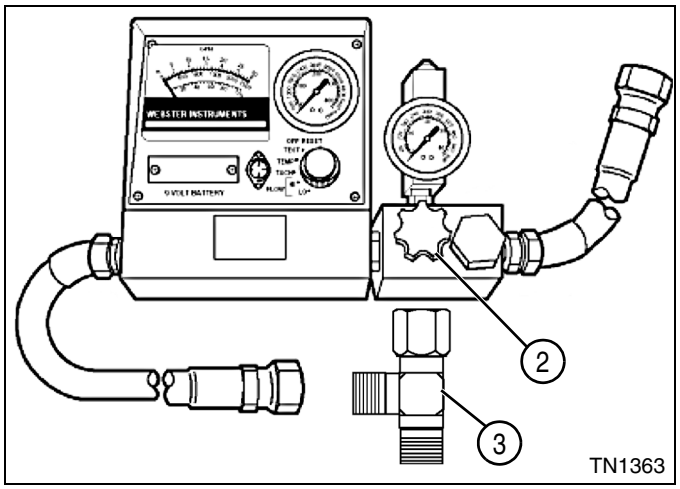


Figure 6-26

3. Install blocking disk between hose (1) and tee fitting (3).
4. Open flow meter valve (2) completely.
5. Bypass seat switch.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

6. Start engine and run at full throttle (2850 rpm ± 50).
7. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve until a reading of 1300 psi (90 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.

CAUTION

Do not exceed 1950 psi (134 bar) when testing pump or equipment damage may occur.

8. Slowly close flow meter valve until pressure reaches 1950 psi (134 bar). Read and record the rear cutting units pump loaded flow.
9. Stop engine.

10. Calculate rear cutting units pump leakage. (Step 14 of previous test – Step 8 / Step 14 of previous test x 100 = Leak Percentage)

    Is rear cutting units pump leakage 10% or less?

    YES *The rear cutting units pump is good. Proceed to next test.*

    NO *Proceed to next question.*

    Is rear cutting units pump leakage 11% to 20%?

    YES *The rear cutting units pump is marginal. Additional testing is required.*

    NO *Proceed to next question.*

    Is rear cutting units pump leakage 21% or more?

    YES *Repair or replace rear cutting units pump. (See "Gear Pump" on page 6-41.)*

11. Disconnect and remove test equipment. Install all hoses and fittings as noted prior to removal.
12. Install and connect all components as noted prior to test.
13. Check hydraulic oil level. Add oil as needed. (Refer to "Safety, Operation, and Maintenance Manual" for correct oil specifications.)

Rear Cutting Units Circuit Valve Tests

See Figures 6-27 and 6-28.

WARNING

The hydraulic system is under pressure, and the oil will be hot.

- **Always relieve pressure in the hydraulic system before performing service.**
- **Failure to follow appropriate safety precautions may result in death or serious injury.**

Required Tools and Materials
• Flow Meter
• -8 ORFS Test Hose 3000 psi (207 bar)
• -8 ORFS Tee Fitting
• -10 ORFS Blocking Disk

1. Park the mower safely. (See "Park Mower Safely" on page 1-5.)
2. Before performing this test, perform rear cutting units circuit test, leaving flow meter connected as outlined.

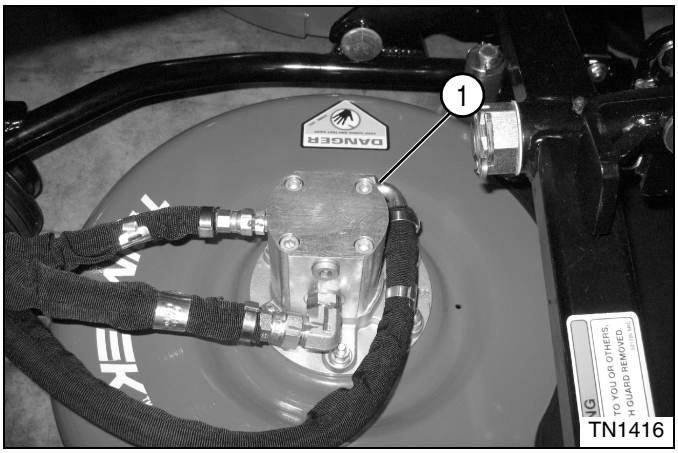


Figure 6-27

3. Install blocking disk at fitting (1) on left rear cutting unit motor, blocking oil flow from entering left rear cutting unit motor.

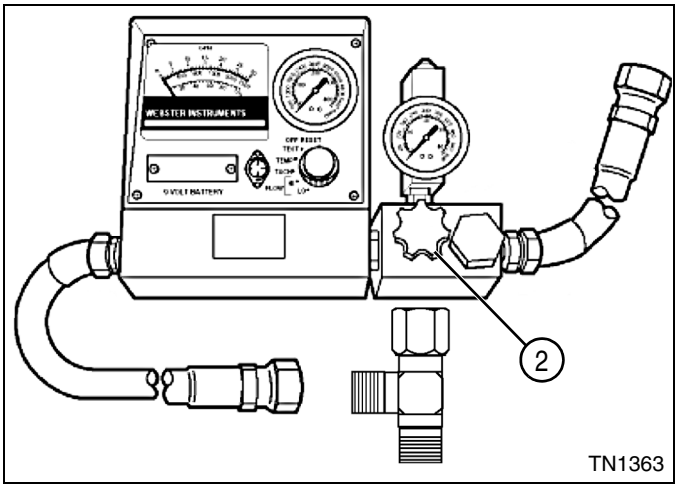


Figure 6-28

4. Open flow meter valve (2) completely.
5. Bypass seat switch.

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

6. Start engine and run at full throttle (2850 rpm ± 50).
7. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve (2) until a reading of 1300 psi (90 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.
8. Disconnect park brake switch.
9. Engage cutting unit switch.
10. Slowly close flow meter valve (2) until pressure reaches 1950 psi (134 bar). Read and record the rear cutting units pump loaded flow.

11. Calculate rear cutting units circuit valve leakage. (Step 8 of previous test – Step 10 / Step 8 of previous test x 100 = Leak Percentage)

    Is rear cutting units circuit valve leakage 10% or less?

    YES *The rear cutting units circuit valve is good. Proceed to* step 12.

    NO *Proceed to next question.*

    Is rear cutting units circuit valve leakage 11% to 20%?

    YES *The rear cutting units circuit valve is marginal. Additional testing is required.*

    NO *Proceed to next question.*

    Is rear cutting units circuit valve leakage 21% or more?

    YES *Repair or replace deck valve. (See "Deck Valve" on page 6-45.)*

CAUTION

Do not exceed 2650 psi (183 bar) when testing system relief valve or equipment damage may occur.

12. Continue to close flow meter valve (2) until zero flow is obtained. Record cutting unit system relief valve pressure.
13. Open flow meter valve (2) and stop engine.

    Is cutting unit system relief valve pressure 2600 psi (179 bar)?

    YES *Cutting unit system relief valve is good. Proceed to* step 14.

    NO *Adjust cutting unit system relief pressure. (See "Adjust Cutting Unit System Relief Valve Pressure" on page 6-28.)*
14. Disconnect and remove test equipment. Install all hoses and fittings as noted prior to removal.
15. Install and connect all components as noted prior to test.
16. Check hydraulic oil level. Add oil as needed. (Refer to "Safety, Operation, and Maintenance Manual" for correct oil specifications.)

Rear Cutting Units Motors Test

See Figure 6-29.

IMPORTANT

- **This test works together with the rear cutting units circuit test to isolate a problem with the rear cutting units circuit.**
- **Performing this test will isolate the rear cutting unit motors from the rest of the rear cutting units circuit.**

WARNING

The hydraulic system is under pressure, and the oil will be hot.

- **Always relieve pressure in the hydraulic system before performing service.**
- **Failure to follow appropriate safety precautions may result in death or serious injury.**

Required Tools and Materials
• Flow Meter • -8 ORFS Test Hose 3000 psi (207 bar) • -8 ORFS Tee Fitting • Blocking Device or Tool

1. Park the mower safely. (See "Park Mower Safely" on page 1-5.)
2. Before performing this test, perform rear cutting units circuit test, leaving flow meter connected as outlined.
3. Bypass seat switch.

IMPORTANT

- **If performing this test after performing rear cutting units circuit test and test proved rear cutting units pump, deck valve, and left rear cutting unit motor good, proceed to step 14.**
- **If performing this test to determine which component in system is at fault (left rear cutting unit motor, center cutting unit motor, or right rear cutting unit motor) continue to step 4.**

WARNING

Safely block cutting unit from rotating using a suitable device or tool. Failure to follow appropriate safety precaution may result in death or serious injury.

4. Install suitable blocking device or tool in left rear cutting unit, preventing cutting unit from turning.

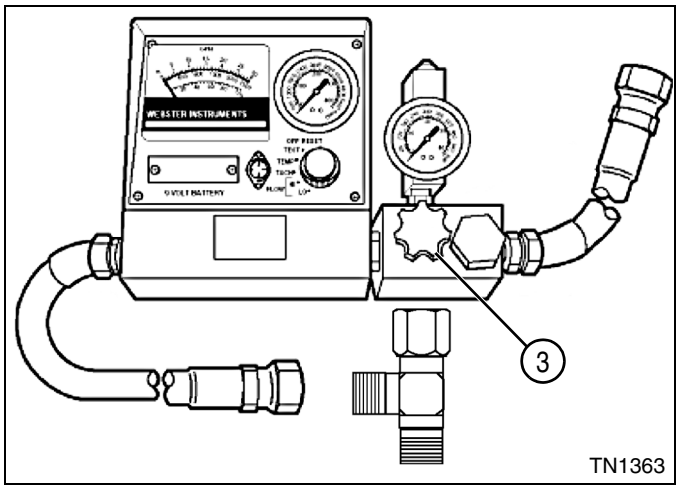


Figure 6-29

5. Open flow meter valve (3) completely.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

6. Start engine and run at full throttle (2850 rpm ± 50).
7. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve (3) until a reading of 1300 psi (90 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.
8. Disconnect park brake switch.
9. Engage cutting unit switch.
10. Slowly close flow meter valve (3) until pressure reaches 1950 psi (134 bar). Read and record the left rear cutting unit motor loaded flow.
11. Open flow meter valve (3) and stop engine.
12. Calculate left rear cutting unit motor leakage. (Step 10 of rear cutting units circuit valve tests – Step 10 / Step 10 of rear cutting units circuit valve tests x 100 = Leak Percentage)

    Is left rear cutting unit motor leakage 10% or less?

    YES *The left rear cutting unit motor is good. Proceed to* step 13.

    NO *Proceed to next question.*

    Is left rear cutting unit motor leakage 11% to 20%?

    YES *The left rear cutting unit motor is marginal. Additional testing is required.*

    NO *Proceed to next question.*

    Is left rear cutting unit motor leakage 21% or more?

    YES *Repair or replace left rear cutting unit motor. (See “Cutting Unit Motors” on page 6-43.)*
13. Remove device or tool from left rear cutting unit.

WARNING

Safely block cutting unit from rotating using a suitable device or tool. Failure to follow appropriate safety precaution may result in death or serious injury.

14. Install suitable blocking device or tool in center cutting unit, preventing cutting unit from turning.
15. Open flow meter valve (3) completely.
16. Connect park brake switch.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

17. Start engine and run at full throttle (2850 rpm ± 50).
18. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve (3) until a reading of 1300 psi (90 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.
19. Disconnect park brake switch.
20. Engage cutting unit switch.
21. Slowly close flow meter valve (3) until pressure reaches 1950 psi (134 bar). Read and record the center cutting unit motor loaded flow.
22. Open flow meter valve (3) and stop engine.

23. Calculate center cutting unit motor leakage. (Step 10 – Step 21 / Step 10 x 100 = Leak Percentage)

    Is center cutting unit motor leakage 10% or less?

    YES *The center cutting unit motor is good. Proceed to* step 24.

    NO *Proceed to next question.*

    Is center cutting unit motor leakage 11% to 20%?

    YES *The center cutting unit motor is marginal. Additional testing required.*

    NO *Proceed to next question.*

    Is center cutting unit motor leakage 21% or more?

    YES *Repair or replace center cutting unit motor. (See "Cutting Unit Motors" on page 6-43.)*

24. Remove device or tool from center cutting unit.

WARNING

Safely block cutting unit from rotating using a suitable device or tool. Failure to follow appropriate safety precaution may result in death or serious injury.

25. Install suitable blocking device or tool in right rear cutting unit, preventing cutting unit from turning.
26. Open flow meter valve (3) completely.
27. Connect park brake switch.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

28. Start engine and run at full throttle (2850 rpm ± 50).
29. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve (3) until a reading of 1300 psi (90 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.
30. Disconnect park brake switch.
31. Engage cutting unit switch.
32. Slowly close flow meter valve (3) until pressure reaches 1950 psi (134 bar). Read and record the right rear cutting unit motor loaded flow.
33. Open flow meter valve (3) and stop engine.
34. Calculate right rear cutting unit motor leakage. (Step 21 – Step 32 / Step 21 x 100 = Leak Percentage)

    Is right rear cutting unit motor leakage 10% or less?

    YES *The right rear cutting unit motor is good. Proceed to* step 35.

    NO *Proceed to next question.*

    Is right rear cutting unit motor leakage 11% to 20%?

    YES *The right rear cutting unit motor is marginal. Proceed to* step 35.

    NO *Proceed to next question.*

    Is right rear cutting unit motor leakage 21% or more?

    YES *Repair or replace right rear cutting unit motor. (See "Cutting Unit Motors" on page 6-43.)*

35. Remove device or tool from right rear cutting unit.
36. Disconnect and remove test equipment. Install all hoses and fittings as noted prior to removal.
37. Install and connect all components as noted prior to test.
38. Check hydraulic oil level. Add oil as needed. (Refer to "Safety, Operation, and Maintenance Manual" for correct oil specifications.)

Lift/Steer System Relief Valve Pressure Test

See Figures 6-30 and 6-31.

WARNING

The hydraulic system is under pressure, and the oil will be hot.

- **Always relieve pressure in the hydraulic system before performing service.**
- **Failure to follow appropriate safety precautions may result in death or serious injury.**

Required Tools and Materials
• Pressure Gauge 5000 psi (345 bar) • -8 ORFS Test Hose 5000 psi (345 bar)

1. Operate hydraulic system until oil temperature is at 120—150°F (49—65°C).

2. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
3. Remove the center floorboard.

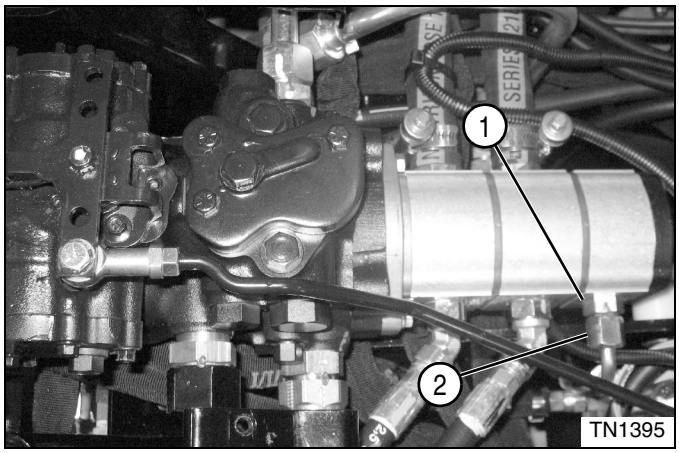


Figure 6-30

Figure 6-31

4. Install tee fitting between fitting (1) and hose (2).
5. Connect test hose from tee fitting to pressure gauge (3).
6. Bypass seat switch.

CAUTION

Do not run mower lift/steer system relief valve over relief longer than 10 seconds or damage may occur to hydraulic system.

7. Start engine and run at full throttle (3150 rpm ± 50).
8. Turn steering wheel fully right against stop.
9. Record pressure reading.
10. Stop engine.

    Is lift/steer system relief pressure 1595 psi (110 bar)?

    YES *Lift/steer system relief valve is good. Proceed to step 11.*

    NO *Test lift/steer pump. (See “Lift/Steer Pump Test” on page 6-39.) Test lift cylinder. (See “Lift Cylinder Leakage Test” on page 6-21.) Replace steering valve. (See “Steering Valve” on page 7-7.)*
11. Disconnect and remove test equipment. Install all hoses and fittings as noted prior to removal.
12. Install and connect all components as noted prior to test.
13. Check hydraulic oil level. Add oil as needed. (Refer to “Safety, Operation, and Maintenance Manual” for correct oil specifications.)

Lift System Test

See Figures 6-32 and 6-33.

WARNING

The hydraulic system is under pressure, and the oil will be hot.

- **Always relieve pressure in the hydraulic system before performing service.**
- **Failure to follow appropriate safety precautions may result in death or serious injury.**

Required Tools and Materials
• Flow Meter • -8 ORFS Test Hose 2000 psi (138 bar) • -8 ORFS Tee Fitting

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove the center floorboard.

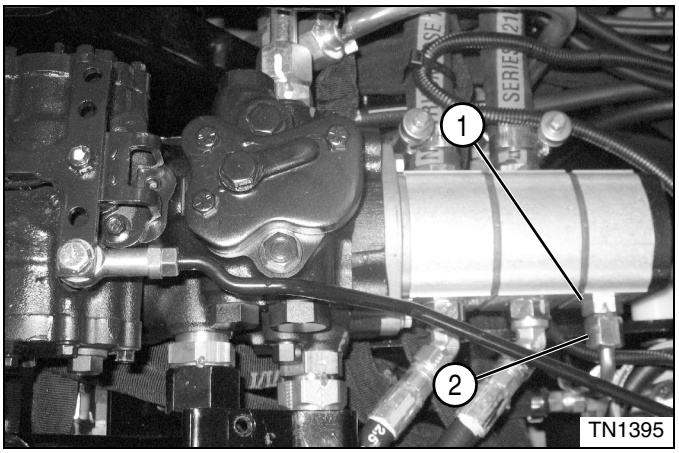


Figure 6-32

3. Disconnect hose (2) from fitting (1).

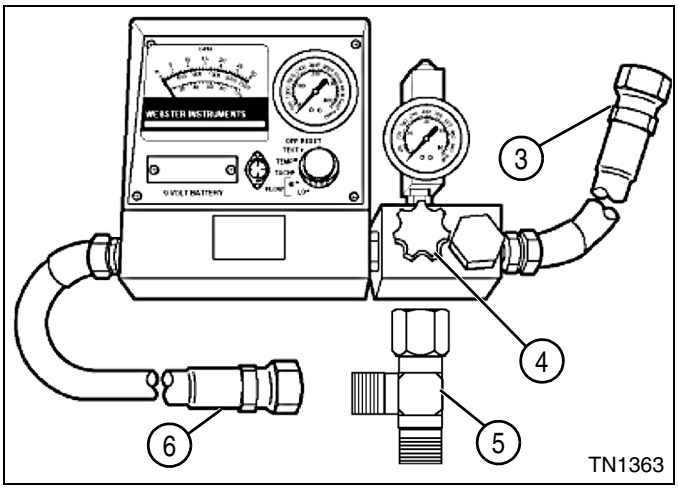


Figure 6-33

4. Install tee fitting (5) to fitting (1).
5. Connect flow meter inlet test hose (6) and hose (2) to tee fitting (5).

NOTE

Make sure hose end is under oil level in hydraulic tank to prevent aeration of oil.

6. Connect flow meter outlet test hose (3) to the hydraulic tank.
7. Open flow meter valve (4) completely.
8. Bypass seat switch.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

9. Start engine and run at full throttle (2850 rpm ± 50).

⚠ CAUTION

Do not exceed 1800 psi (124 bar) as this test does not utilize system relief.

10. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve (4) until a reading of 900 psi (62 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.
11. Hold the lever in the raise position.
12. Read and record the lift/steer pump no load flow.
13. While holding the raise/lower lever in the raise position, slowly close flow meter valve (4) until pressure reaches 1300 psi (90 bar).
14. Hold the lever in the raise position.
15. Read and record the lift/steer pump loaded flow.
16. Open flow meter valve (4) and stop engine.
17. Calculate lift system leakage. (Step 12 – Step 15 / Step 12 x 100 = Leak Percentage)

    Is lift system leakage 10% or less?

    YES *The lift system is good. Proceed to step 18.*

    NO *Proceed to next question.*

    Is lift system leakage 11% to 20%?

    YES *The lift system is marginal. Additional testing is required.*

    NO *Proceed to next question.*

    Is lift system leakage 21% or more?

    YES *Test individual components in lift system for leakage.*

18. Disconnect and remove test equipment. Install all hoses and fittings as noted prior to removal.
19. Install and connect all components as noted prior to test.
20. Check hydraulic oil level. Add oil as needed. (Refer to “Safety, Operation, and Maintenance Manual” for correct oil specifications.)

Lift/Steer Pump Test

WARNING

The hydraulic system is under pressure, and the oil will be hot.

- **Always relieve pressure in the hydraulic system before performing service.**
- **Failure to follow appropriate safety precautions may result in death or serious injury.**

Required Tools and Materials
• Flow Meter • -8 ORFS Test Hose 2000 psi (138 bar) • -8 ORFS Tee Fitting • -8 ORFS Blocking Disk

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Before performing this test perform lift system test. Leave flow meter connected as outlined in lift system test. Install blocking disk between hose (2) and tee fitting (5). (*See “Lift System Test” on page 6-37.)*
3. Open flow meter valve (4) completely. (See Figure 6-33.)
4. Bypass seat switch.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

5. Start engine and run at full throttle (2850 rpm ± 50).

CAUTION

Do not exceed 1800 psi (124 bar) as this test does not utilize system relief.

6. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve (4) until a reading of 900 psi (62 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C).
7. Open flow meter valve (4) completely. Read and record the lift/steer pump no load flow.
8. Slowly close flow meter valve (4) until pressure reaches 1300 psi (90 bar). Read and record the lift/steer pump loaded flow.
9. Open flow meter valve (4) and stop engine.
10. Calculate lift/steer pump leakage.
    (Step 7 – Step 8 / Step 7 x 100 = Leak Percentage)

    Is lift/steer pump leakage 10% or less?

    YES *The lift/steer pump is good. Proceed to* step 11.

    NO *Proceed to next question.*

    Is lift/steer pump leakage 11% to 20%?

    YES *The lift/steer pump is marginal. Additional testing is required.*

    NO *Proceed to next question.*

    Is lift/steer pump leakage 21% or more?

    YES *Repair or replace lift/steer pump. (See “Gear Pump” on page 6-41.)*
11. Disconnect and remove test equipment. Install all hoses and fittings as noted prior to removal.
12. Install and connect all components as noted prior to test.
13. Check hydraulic oil level. Add oil as needed. (Refer to “Safety, Operation, and Maintenance Manual” for correct oil specifications.)

Lift Valve Test

See Figures 6-34 and 6-35.

WARNING

The hydraulic system is under pressure, and the oil will be hot.

- **Always relieve pressure in the hydraulic system before performing service.**
- **Failure to follow appropriate safety precautions may result in death or serious injury.**

Required Tools and Materials
• Flow Meter • -8 ORFS Test Hose 2000 psi (138 bar) • -8 ORFS Tee Fitting • -6 ORFS Blocking Disk

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Before performing this test, perform lift system test. Leave flow meter connected as outlined in lift system test. (*See “Lift System Test” on page 6-37.)*

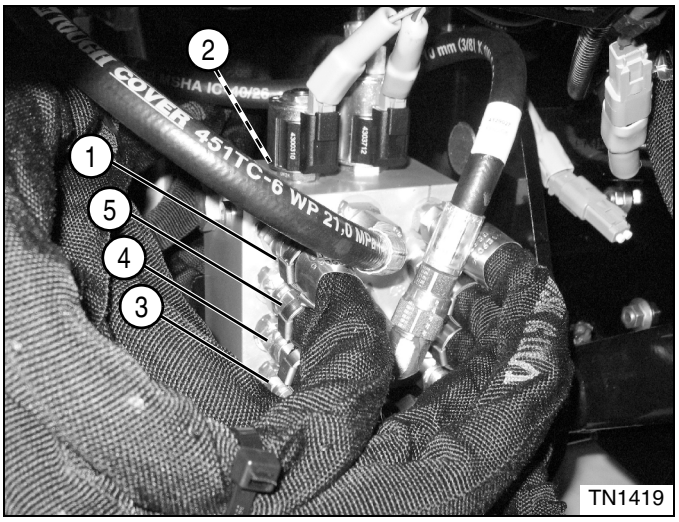


Figure 6-34

3. Install blocking disks at fittings (1—5) on lift valve, preventing oil flow from entering lift cylinders.

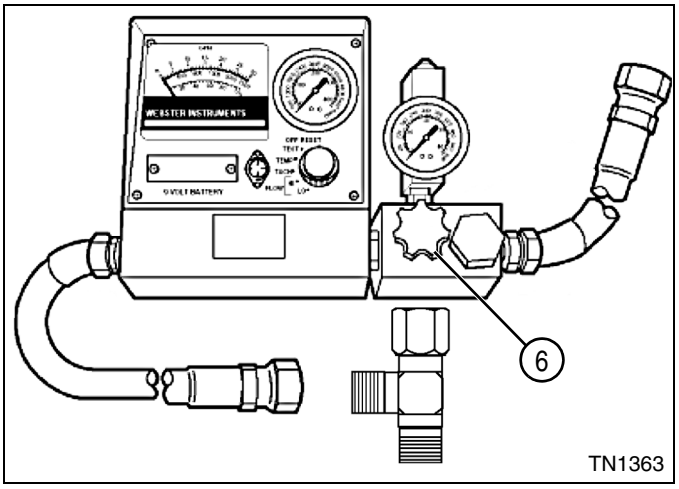


Figure 6-35

4. Open flow meter valve (6) completely.
5. Bypass seat switch.

NOTE

Verify engine rpm is within specification (2850 rpm ± 50) to ensure accurate hydraulic test results.

6. Start engine and run at full throttle (2850 rpm ± 50).
7. Use the flow meter to warm the hydraulic oil. Turn the flow meter valve (6) until a reading of 900 psi (62 bar) or one half of the relief valve rating is reached. Warm oil to 120—150°F (49—65°C); open valve fully after operating temperature is reached.
8. Hold the lever in the raise position.
9. Slowly close flow meter valve (6) until pressure reaches 1300 psi (90 bar). Read and record the lift/steer pump loaded flow.
10. Open flow meter valve (6) and stop engine.
11. Calculate lift valve leakage.
    (Step 8 of previous test – Step 9 / Step 8 of previous test x 100 = Leak Percentage)

    Is lift valve leakage 10% or less?

    YES *The lift valve is good. Proceed to step 12.*

    NO *Proceed to next question.*

    Is lift valve leakage 11% to 20%?

    YES *The lift valve is marginal. Repair or replace as needed.*

    NO *Proceed to next question.*

    Is lift valve leakage 21% or more?

    YES *Repair or replace lift valve. (See “Lift Valve” on page 6-44.)*
12. Disconnect and remove test equipment. Install all hoses and fittings as noted prior to removal.
13. Install and connect all components as noted prior to test.
14. Check hydraulic oil level. Add oil as needed. (Refer to “Safety, Operation, and Maintenance Manual” for correct oil specifications.)

Repair

Gear Pump

Removal and Installation

See Figure 6-36.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove the center floorboard.
3. Remove the seat and mount plate. (See “Seat and Mount Plate” on page 9-10.)
4. Drain hydraulic oil.

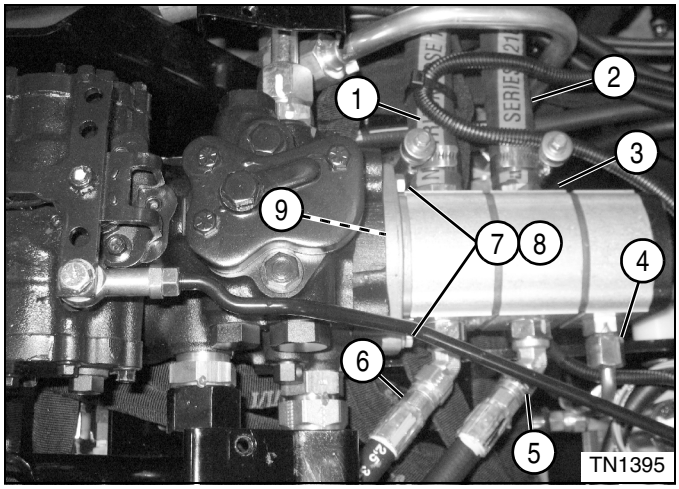


Figure 6-36

NOTES

- *Label all hydraulic hoses and tubes before disconnecting to aid in installation.*
- *Close all openings with caps or plugs to prevent contamination.*

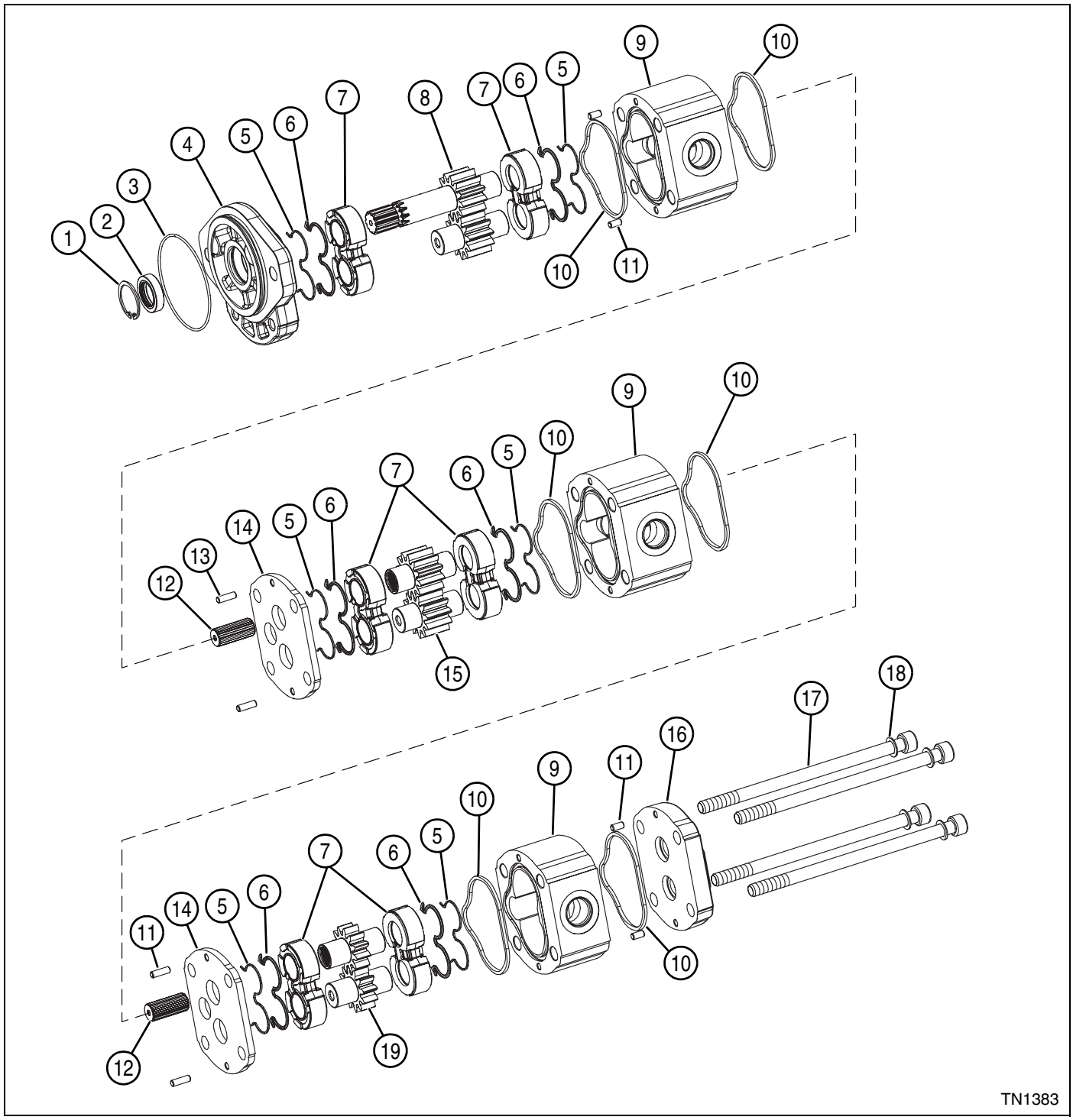
5. Remove hoses (1 and 2).
6. Disconnect hoses (4—6).
7. Support gear pump assembly (3).
8. Remove two screws (7) and lock washers (8).
9. Remove gear pump (3).
10. Remove O-ring (9).

Installation Notes

- *Install gear pump by reversing the order of removal.*
- *Ensure new O-rings are in place before installing hoses on fittings.*
- *Replace hydraulic oil filter.*
- *Refill hydraulic tank. (Refer to “Safety, Operation, and Maintenance Manual” for oil specifications.)*
- *Install seat and mounting plate.*
- *Start engine. Check hydraulic system for leaks. Repair as necessary.*
- *Check hydraulic oil level and add if necessary.*

Disassembly, Inspection, and Assembly

See Figure 6-37.



1	Retaining Ring	6	Seal (6)	11	Dowel Pin (4)	16	Rear Cover
2	Seal	7	Thrust Plate (6)	12	Splined Connecting Shaft (2)	17	Bolt (4)
3	O-Ring	8	Gear Set (Drive Shaft)	13	Dowel Pin (4)	18	Washer (4)
4	Front Cover/Flange	9	Body (3)	14	Spacer (2)	19	Gear Set, End
5	Backup Washer (6)	10	Seal (6)	15	Gear Set, Intermediate		

Figure 6-37

Disassembly Notes

- *Do not disassemble pump for repair unless test procedures indicate internal leakage.*
- *Never pry components apart. Use a soft face hammer, and gently tap housing and shaft to separate pump bodies.*
- *Scribe or mark the pump bodies and end covers before disassembly to aid in assembly. Recommended method of marking body sections is to use a fine point metal punch, making one indentation for section #1, two indentations for section #2, etc.*

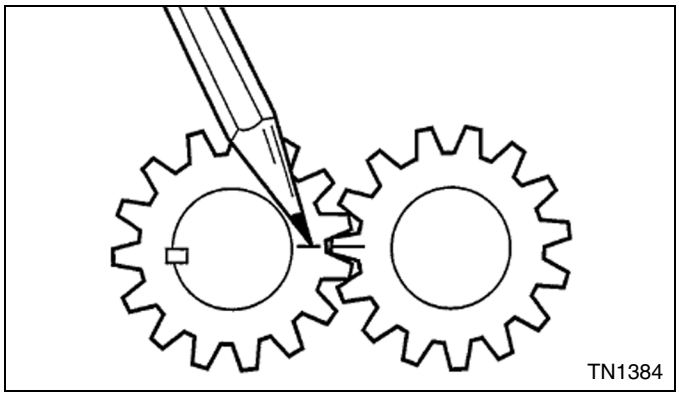


Figure 6-38

1. After removing bolts, disassemble pump, one section at a time. Before removing gear set, mark a line across meshing teeth to ensure that gears are reassembled in the same position.
2. Place parts in assembly order, on a clean work area as they are removed.
3. Discard seals as they are removed.

NOTICE

It is important that all components are absolutely clean, as contamination can result in serious damage and/or improper operation.

Never use shop towels or rags to dry parts after cleaning, as lint may clog passages. Dry parts using compressed air.

4. Clean all parts using clean solvent, and dry using compressed air.
5. Inspect all parts for wear or damage. Replace parts as needed.

Assembly Notes

NOTICE

It is important that all component parts are absolutely clean, as contamination can result in serious damage and/or improper operation.

Never use shop towels or rags to dry parts after cleaning, as lint may clog passages. Dry parts using compressed air.

Required Materials
Seal Kit (Jacobsen P/N 4174881)

- *Assemble the gear pump by reversing the order of disassembly.*
- *Use a new seal kit during assembly.*
- *Apply a coat of clean hydraulic oil to all parts to ease assembly.*
- *Assemble pump one, section at a time, building up from flange section.*
- *Remove alignment mark from gear sets after gears have been installed with teeth in proper mesh.*
- *Make sure that bushing sets are correctly installed to properly position the high pressure seals.*
- *Rotate drive shaft by hand after assembling each section to make sure there is no binding between parts; do not force.*
- *Use extreme care when installing shaft seal. Seal must seat squarely in seal bore. Use caution not to damage seal when installing cover over pump shaft.*
- *Install retaining bolts finger-tight and rotate drive shaft to make sure it turns freely. Tighten bolts evenly in steps to a final torque of 33 lb-ft (45 N·m) and check rotation of pump drive shaft.*
- *Lubricate pump through ports with clean hydraulic oil prior to installing.*

Cutting Unit Motors

Removal and Installation

NOTE

See Chapter 8—Cutting Units for cutting unit motor service information. (See “Deck Motor” on page 8-12.)

Lift Valve

Removal and Installation

See Figures 6-39 and 6-40.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Remove the center floorboard.

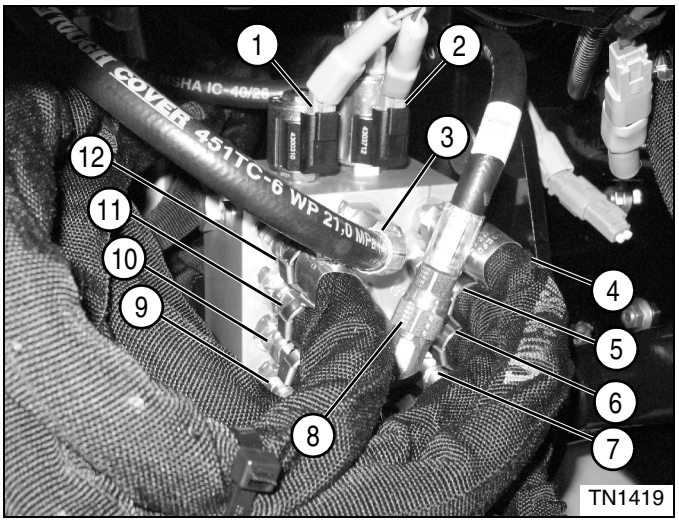


Figure 6-39

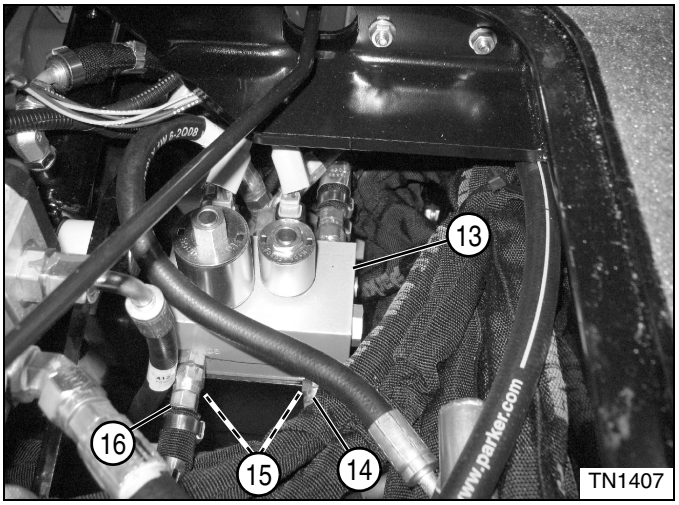


Figure 6-40

NOTE

Label connectors before disconnecting to ensure correct installation.

3. Disconnect electrical connectors (1 and 2).

NOTES

- *Label hydraulic hoses to aid in installation.*
- *Close all openings with caps or plugs to prevent contamination.*

4. Disconnect hydraulic hoses (3—12).
5. Disconnect hydraulic hoses (14 and 16).
6. Support lift valve (13).
7. Remove the two mounting screws (15).
8. Remove lift valve (13).

Installation Notes

- *Install the lift valve by reversing the order of removal.*
- *Ensure new O-rings are in place before installing hoses on fittings.*
- *Replace hydraulic oil filter.*
- *Refill hydraulic tank. (Refer to “Safety, Operation, and Maintenance Manual” for oil specifications.)*
- *Start engine. Check hydraulic system for leaks. Repair as necessary.*
- *Check hydraulic oil level and add if necessary.*

Disassembly, Inspection, and Assembly

See Figures 6-41 and 6-42.

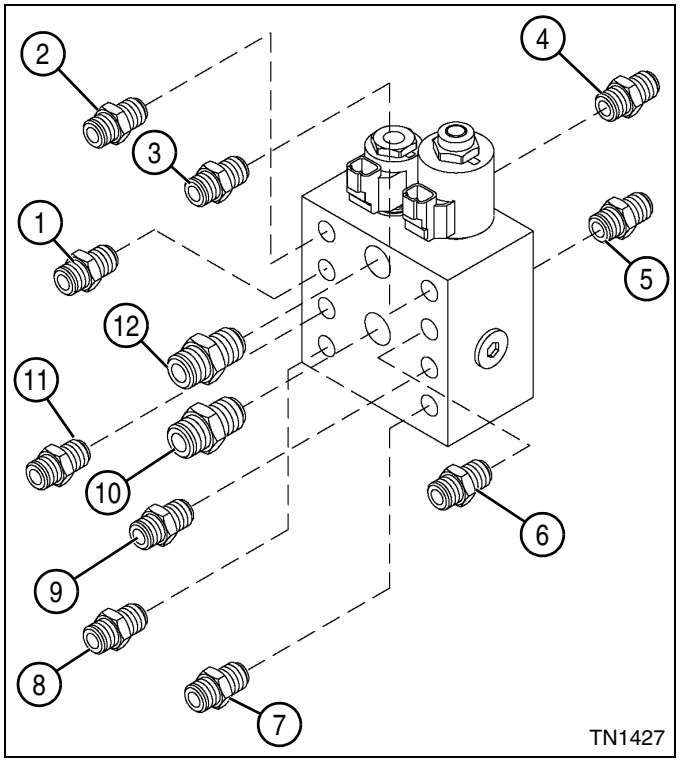
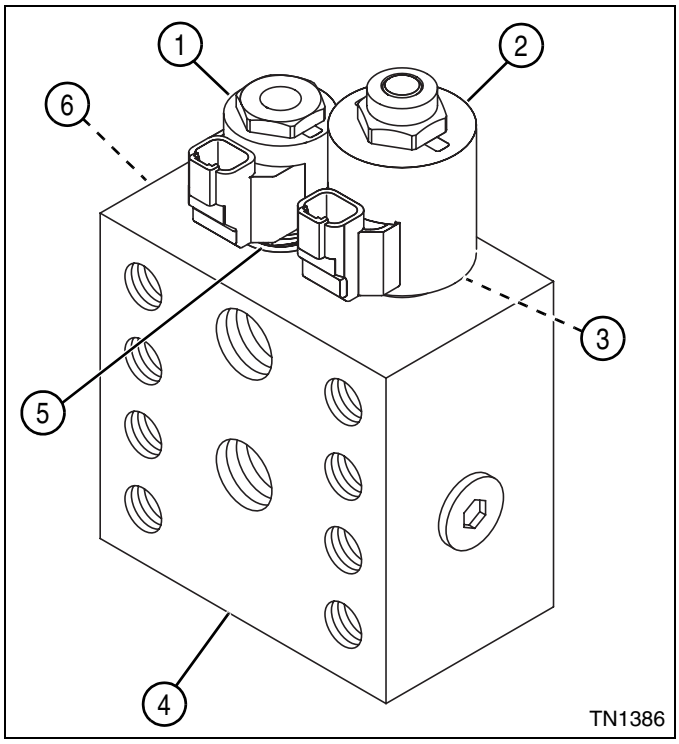


Figure 6-41

1. Remove fittings (1—12) from the lift valve.



1 Lower Solenoid Coil
2 Raise Solenoid Coil
3 Solenoid Valve, Raise
4 Lift Valve Block
5 Solenoid Valve, Lower/Proportional
6 Check Valve Cartridge

Figure 6-42

2. Remove, inspect, and replace lift valve components as needed.

NOTICE

It is important that all component parts are absolutely clean, as contamination can result in serious damage and/or improper operation.

Never use shop towels or rags to dry parts after cleaning, as lint may clog passages. Dry parts using compressed air.

3. Clean all parts using clean solvent, and dry using compressed air.
4. Inspect all parts for wear or damage. Replace parts as needed.

Assembly Notes

NOTICE

It is important that all component parts are absolutely clean, as contamination can result in serious damage and/or improper operation.

Never use shop towels or rags to dry parts after cleaning, as lint may clog passages. Dry parts using compressed air.

Required Materials
Seal Kit, Check Valve (Jacobsen P/N 5003579) Seal Kit, Raise Solenoid Valve (Jacobsen P/N 5003579) Seal Kit, Lowering/Proportional Solenoid Valve (Jacobsen P/N 5003578)

- *Assemble the lift valve by reversing the order of disassembly.*
- *Lubricate all O-rings prior to assembly.*

Deck Valve

Removal and Installation

See Figure 6-43.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Drain hydraulic oil.
3. Thoroughly clean the valve, especially the area surrounding the hydraulic hoses, tubes, and fittings.

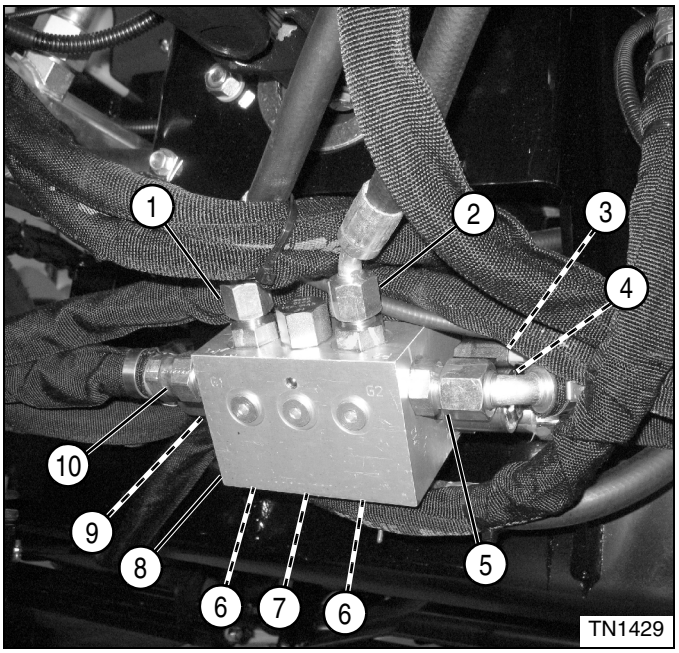


Figure 6-43

NOTE

Label connector before disconnecting to ensure correct installation.

4. Disconnect electrical connector (4) from solenoid.

NOTES

- *Label all hydraulic hoses and tubes before disconnecting to aid in installation.*
- *Close all openings with caps or plugs to prevent contamination.*

5. Disconnect hydraulic hoses (1—3).
6. Disconnect hydraulic hoses (5 and 7).
7. Disconnect hydraulic hoses (9 and 10).
8. Support the deck valve (8).
9. Remove the two mounting screws, lock washers, and washers (6) from the deck valve (8).
10. Remove the deck valve (8).

Installation Notes

- *Install the deck valve by reversing the order of removal.*
- *Ensure new O-rings are in place before installing hoses on fittings.*
- *Replace hydraulic oil filter.*
- *Refill hydraulic tank. (Refer to "Safety, Operation, and Maintenance Manual" for oil specifications.)*
- *Start engine. Check hydraulic system for leaks. Repair as necessary.*
- *Check hydraulic oil level and add if necessary.*

Disassembly, Inspection, and Assembly

See Figures 6-44 and 6-45.

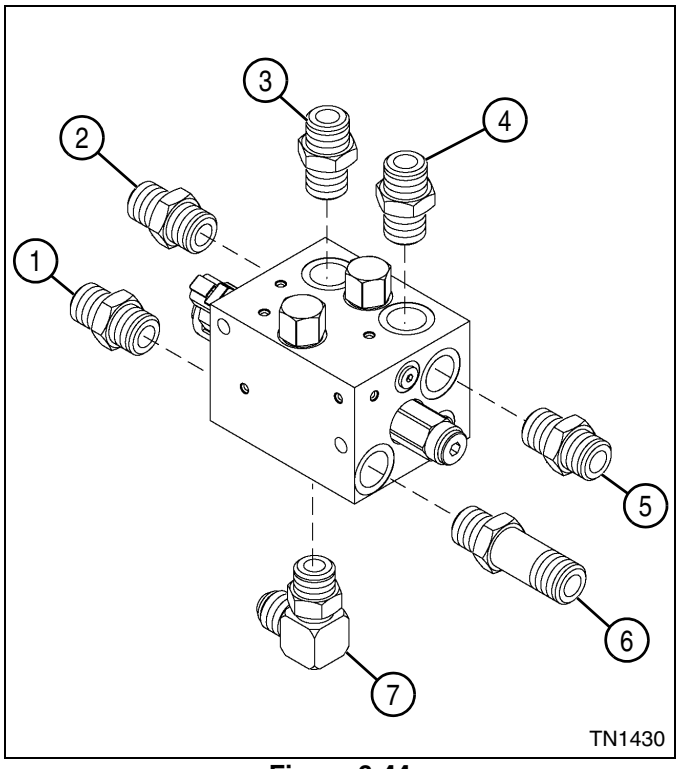
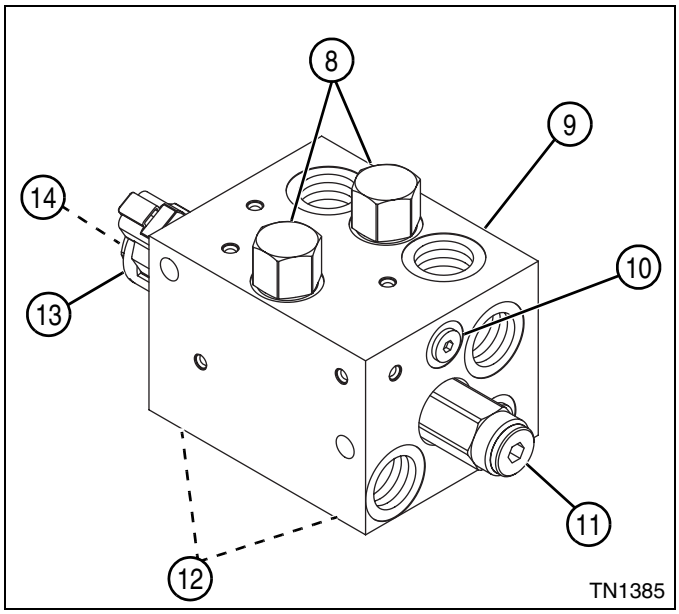


Figure 6-44

1. Remove fittings (1—7) from the lift valve.



8 Vented Logic Element Valve (2)
9 Deck Valve Block
10 Load Shuttle Valve
11 Relief Valve
12 Check Valve
13 Mow Solenoid Coil
14 Mow Solenoid Valve

Figure 6-45

NOTICE

It is important that all component parts are absolutely clean, as contamination can result in serious damage and/or improper operation.

Never use shop towels or rags to dry parts after cleaning, as lint may clog passages. Dry parts using compressed air.

2. Clean all parts using clean solvent, and dry using compressed air.
3. Inspect all parts for wear or damage. Replace parts as needed.

Assembly Notes

NOTICE

It is important that all component parts are absolutely clean, as contamination can result in serious damage and/or improper operation.

Never use shop towels or rags to dry parts after cleaning, as lint may clog passages. Dry parts using compressed air.

Required Materials
Seal Kit, Vented Logic Element Valve (Jacobsen P/N 5003579)
Seal Kit, Relief Valve (Jacobsen P/N 5003578)
Seal Kit, Solenoid Valve (Jacobsen P/N 5003578)
Seal Kit, Check Valve (Jacobsen P/N 5003579)
Seal Kit, Load Shuttle Valve (Jacobsen P/N 4134543)

- *Assemble the deck valve by reversing the order of disassembly.*
- *Lubricate all O-rings prior to assembly.*
- *Tighten cartridges and relief valve to 25 lb-ft (34 N·m).*

Hydraulic Filter

Removal and Installation

See Figure 6-46.

1. Park the mower safely. (See “Park Mower Safely” on page 1-5.)
2. Raise engine hood.
3. Drain hydraulic tank.

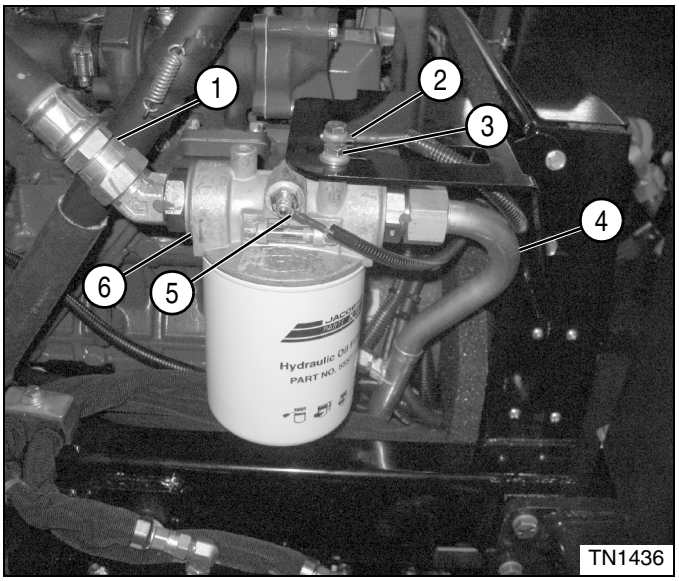


Figure 6-46

4. Disconnect electrical connectors (2 and 5).

NOTES

- *Label all hydraulic hoses and tubes to aid in installation.*
- *Close all openings with caps or plugs to prevent contamination.*

5. Disconnect hydraulic hose (1).
6. Disconnect hydraulic tube (4).
7. Support the oil filter assembly (6).
8. Remove screw, lock washer, and flat washer (3).
9. Remove oil filter assembly (6).

Installation Notes

- *Install oil filter assembly by reversing the order of removal.*
- *Replace hydraulic oil filter. (Refer to "Safety, Operation, and Maintenance Manual" for oil specifications.)*
- *Refill hydraulic tank. (Refer to "Safety, Operation, and Maintenance Manual" for oil specifications.)*
- *Start engine. Check hydraulic system for leaks. Repair as necessary.*
- *Check hydraulic oil level and add if necessary.*

Lift Cylinders

Removal and Installation

See Figure 6-47.

CAUTION

Care must be taken to avoid damaging the surface of the cylinder rod during removal and installation.

1. Lower cutting units.
2. Park the mower safely. (See “Park Mower Safely” on page 1-5.)

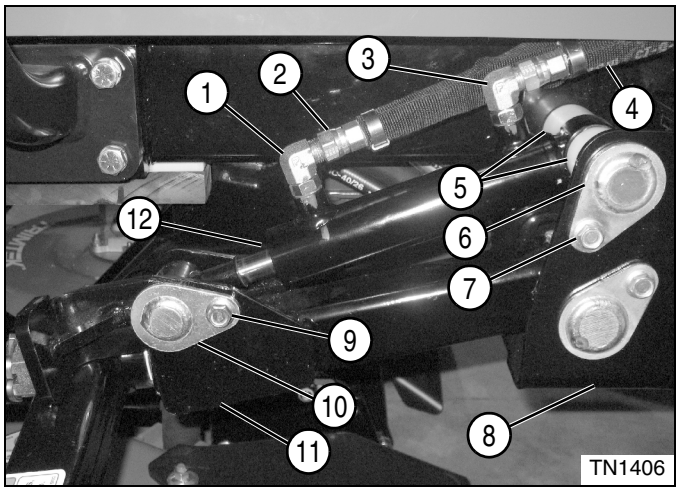


Figure 6-47

NOTES

- *Label all hydraulic hoses before disconnecting to ensure correct installation.*
- *All of the lift cylinders have an orifice installed between the hose and one of the cylinder fittings. Note the location of the orifice and recover the orifice when removing the hydraulic hoses.*
- *Close all openings with caps or plugs to prevent contamination.*

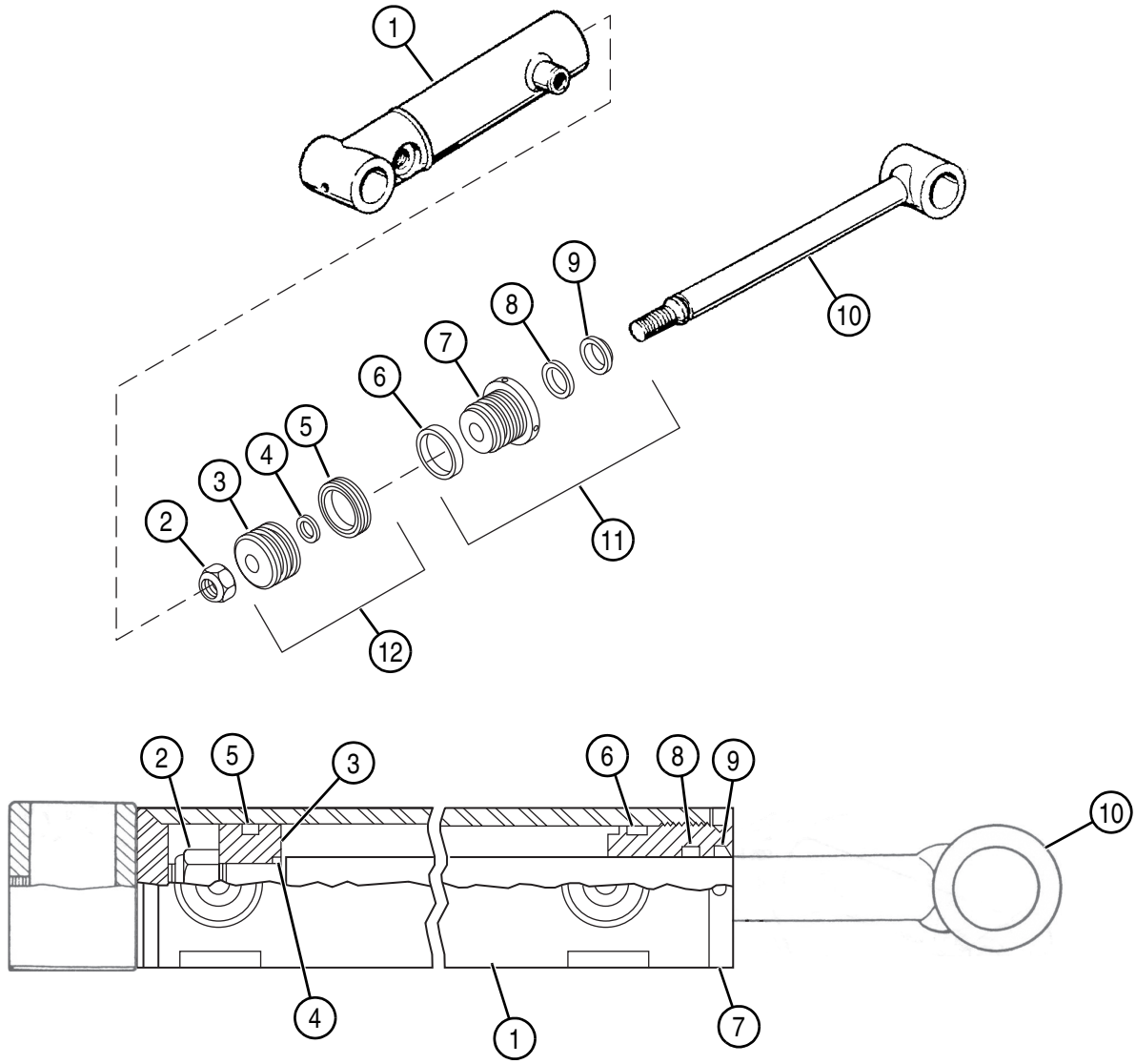
3. Disconnect hydraulic hoses (2 and 4) from fittings (1 and 3).
4. Remove screw (7), pin (6), and spacers (5) from lift cylinder (12) and bracket (8).
5. Remove screw (9) and pin (10) from the lift cylinder (12) and lift arm (11).
6. Remove lift cylinder (12).

Installation Notes

- *Install lift cylinder by reversing the order of removal.*
- *Ensure new O-rings are in place before installing hoses on fittings.*
- *Replace hydraulic oil filter.*
- *Refill hydraulic tank. (Refer to “Safety, Operation, and Maintenance Manual” for oil specifications.)*
- *Start engine. Check hydraulic system for leaks. Repair as necessary.*
- *Check hydraulic oil level and add if necessary.*

Disassembly, Inspection, and Assembly

See Figure 6-48.



1	Barrel	4	O-Ring	7	Rod Guide	10	Rod
2	Nut	5	Piston Ring	8	O-Ring	11	Rod Guide Assembly
3	Piston	6	Seal Ring	9	Rod Wiper	12	Piston Assembly

Figure 6-48

NOTE

During repair of the cylinder, use extreme care not to damage the barrel, piston, rod, and sealing surfaces of the cylinder.

1. Drain oil from lift cylinder.
2. Remove fittings from lift cylinder.
3. Use a spanner wrench to remove the rod guide assembly (7) from the barrel (1).
4. Remove nut (2).
5. Remove the piston assembly (12) and rod guide assembly (11) from the rod (10).
6. Remove the piston ring (5) and O-ring (4) from the piston (3).
7. Remove the seal ring (6), rod wiper (9), and O-ring (8) from the rod guide (7).

NOTICE

It is important that all component parts are absolutely clean, as contamination can result in serious damage and/or improper operation.

Never use shop towels or rags to dry parts after cleaning, as lint may clog passages. Dry parts using compressed air.

8. Clean all parts using clean solvent, and dry using compressed air.
9. Inspect all parts for excessive wear, cracks, broken parts, and scoring of the cylinder barrel, piston, and rod.

Assembly Notes

NOTICE

It is important that all component parts are absolutely clean, as contamination can result in serious damage and/or improper operation.

Never use shop towels or rags to dry parts after cleaning, as lint may clog passages. Dry parts using compressed air.

Required Materials
Seal Kit (Jacobsen P/N 4137138)

- *Lubricate O-rings, seals, and rod wiper with clean hydraulic oil before assembly.*
- *Assemble the lift cylinder by reversing the order of disassembly.*

Hydraulic Oil Cooler

Removal and Installation

NOTE

The hydraulic oil cooler is combined with the radiator and uses the engine cooling fan to cool the hydraulic oil. Removal and installation of the radiator/hydraulic oil cooler is described in Chapter 3—Engine. (See "Radiator/Hydraulic Oil Cooler" on page 3-10.)

Hydraulic Oil Tank

Removal and Installation

See Figures 6-49 through 6-51.

1. Park the mower safely. (See "Park Mower Safely" on page 1-5.)
2. Disconnect the negative (–) battery cable from the battery.
3. Place a suitable container beneath hydraulic oil tank.
4. Drain hydraulic oil from hydraulic tank.

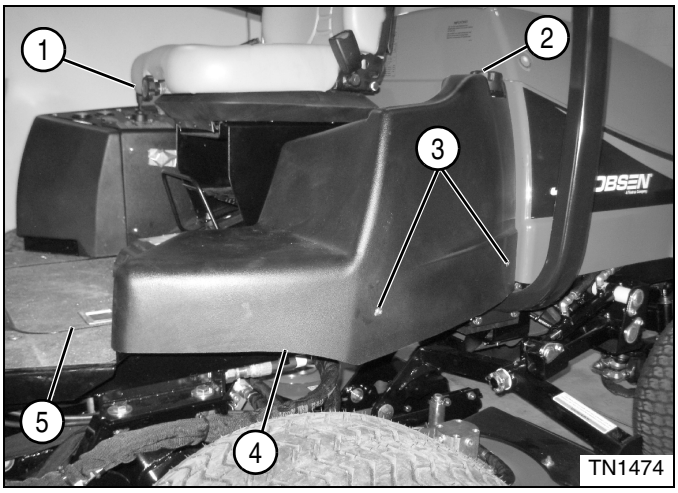


Figure 6-49

5. Remove center floorboard (5) and seat (1).
6. Remove filler cap (2), five screws (3), and tank cover (4).

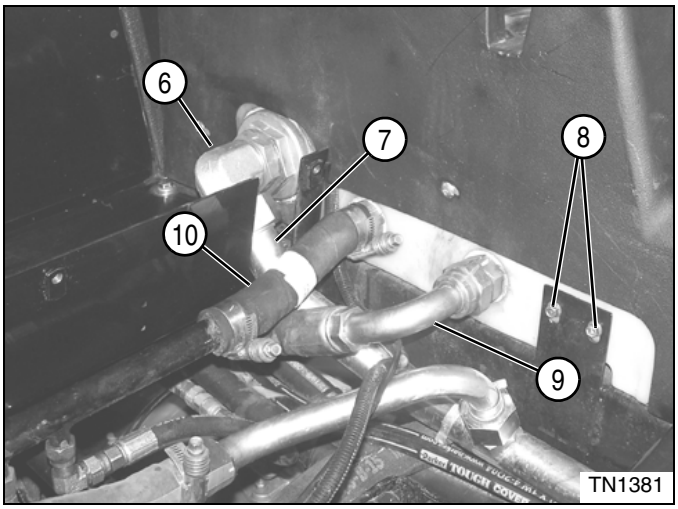


Figure 6-50

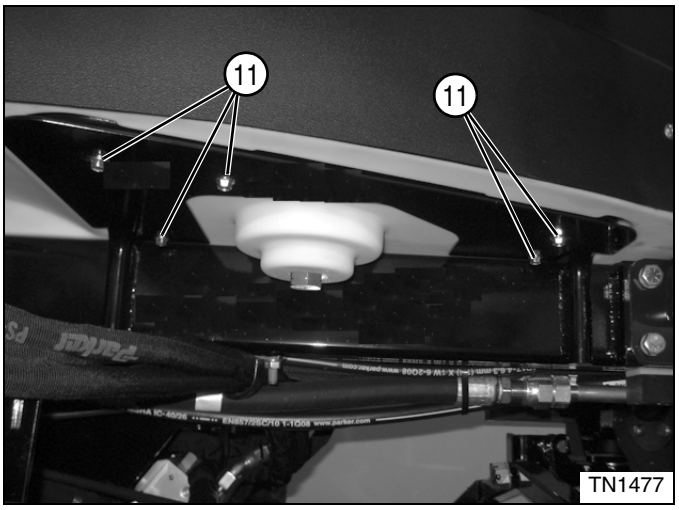


Figure 6-51

NOTES

- *Label all hydraulic hoses and tubes before disconnecting to aid in installation.*
- *Close all openings with caps or plugs to prevent contamination.*

7. Disconnect hose (7) from fitting (6).
8. Disconnect hoses (9 and 10) from hydraulic oil tank.
9. Support the hydraulic oil tank.
10. Remove two screws (8).
11. Remove five screws (11) from the bottom of the hydraulic oil tank.
12. Remove the hydraulic oil tank.

Installation Notes

Required Materials
Anti-Seize Compound

- *Install hydraulic oil tank by reversing the order of removal.*

CAUTION

- **When connecting fittings to the tank, be sure to hold the tank fitting with the proper wrench. If the proper wrench is not used, the fitting in the tank might break loose from the plastic and cause it to leak.**
- **Do not over torque screws to tank or tank may crack and cause leak.**

- *Apply anti-seize compound to screws (11) and tighten to correct torque. Do not over torque these screws or tank may crack and cause leak.*
- *Ensure new O-rings are in place before installing hoses on fittings.*
- *Replace hydraulic oil filter.*
- *Refill hydraulic oil tank. (Refer to "Safety, Operation, and Maintenance Manual" for oil specifications.)*
- *Start engine. Check hydraulic oil tank for leaks and repair as necessary.*
- *Check hydraulic oil level and add if necessary.*