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MANUALS ARE MODEL AND SERIAL NUMBER SPECIFIC.

If additional printed manuals are required for your shop/office location, order by part number through the factory's Parts Center.

If a retail customer needs replacement manual(s) for a specific unit, contact the factory's Customer Data Center at: 800-829-0051 or customerdata@vermeermfg.com

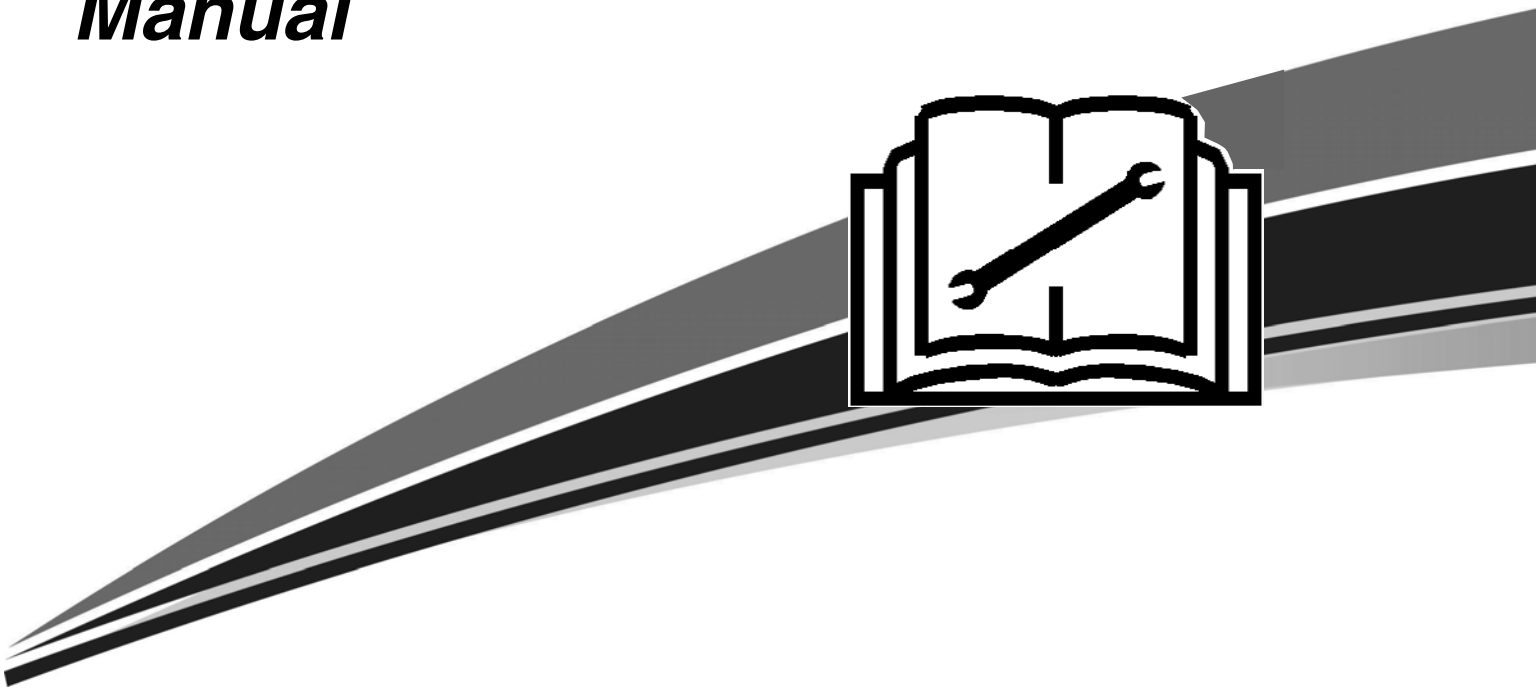
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T655*III* Tractor/Attachments

Service Manual



T655III_S1_00
Serial No. 101 -
Order No. 105400AE4

Vermeer®

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This manual contains service requirements and procedures needed by an experienced service person to complete necessary service and repairs on the machine. Study and understand these requirements and procedures thoroughly before servicing or repairing the machine. There are also many components which are not user-serviceable. Do not attempt any service which you do not fully understand, nor any service that you cannot do adequately and safely with the tools and equipment available to you. Failure to do so could result in personal injury or equipment damage. If you encounter a problem that you do not understand or cannot solve, contact your Vermeer service representative.

The instructions, illustrations and specifications in this manual are based on the latest information available at the time of publication. Your machine may have product improvements and options not yet contained in this manual.

Vermeer Manufacturing Company reserves the right to make changes at any time without notice or obligation.

Additional copies of this manual are available. When ordering, use the part number on the front cover.

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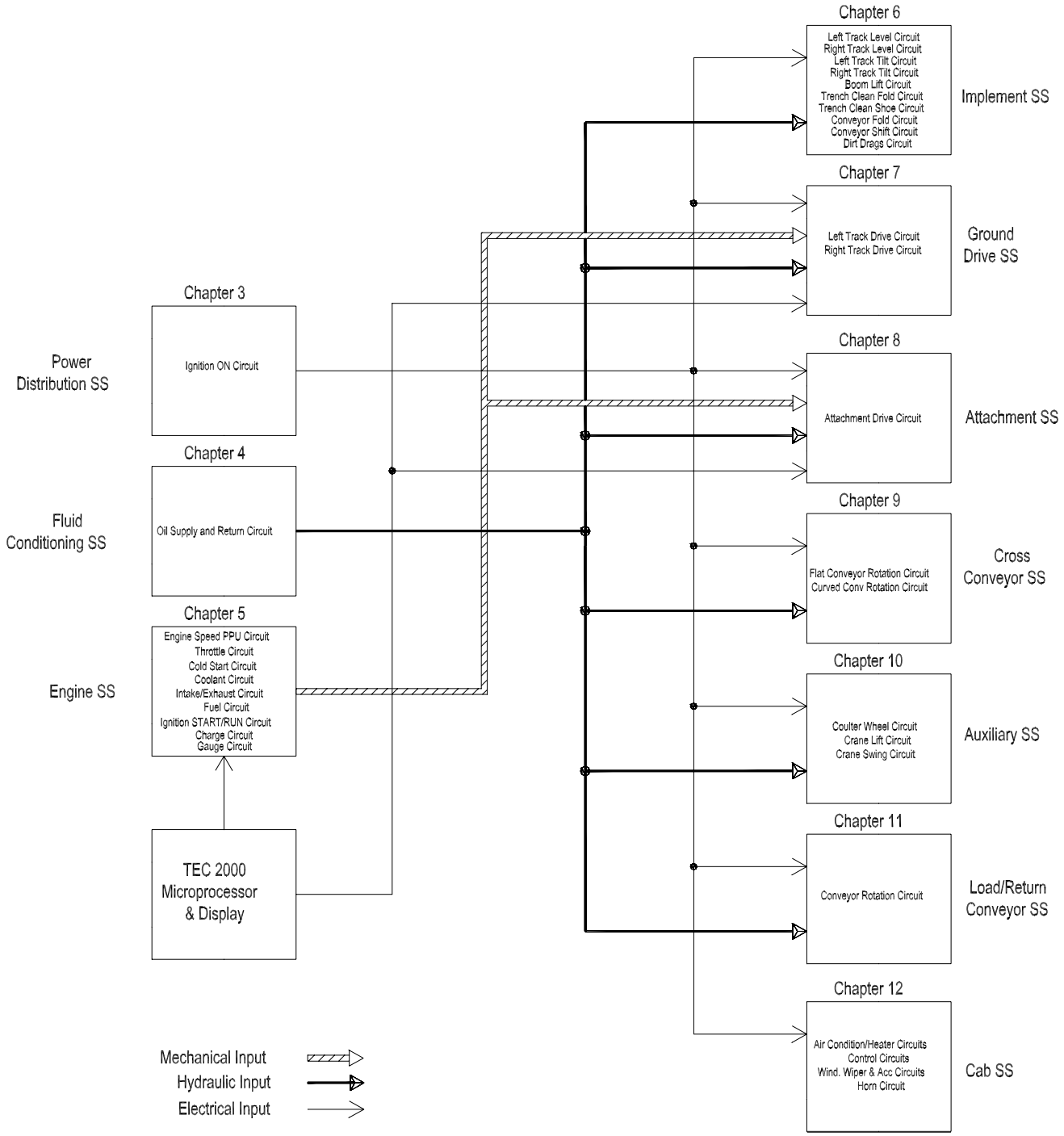
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SYSTEM MAP

The term system refers to the entire machine. The system level map below shows the system divided into subsystems (SS). Lines and arrows on the map indicate which subsystems receive hydraulic, electric, and mechanical input from the shared (common) subsystems and microprocessor. Refer to the general table of contents on the following pages for specific subsystem and circuit information.



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NOTE: Refer to the individual table of contents preceding each chapter for specific information.

Chapter 1 - General Information SS:

Chapter 2 - System Information SS:

Chapter 3 - Power Distribution SS:

- Theory - section 3A
- Troubleshooting - section 3B
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- Troubleshooting - section 9B
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- Theory - section 10A
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- Repair - section 11C

Chapter 12 - Cab SS:

- Theory - section 12A
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Chapter 1—General Information

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Chapter 1: General Information

Introduction

USING THE MANUAL

This manual provides information and service procedures based upon current machine knowledge and configuration at the time the manual was written. The instructions, illustrations and specifications are based on the latest information available at the time of publication. Due to ongoing efforts to continuously improve the equipment, there may be changes on the machine not yet reflected in this manual.

Vermeer Manufacturing Company reserves the right to make changes at any time without notice or obligation.

Procedures given in this manual provide one method for completing a given task. Additional information may be available through Vermeer Service Support resources.

Additional copies of this manual are available through the Vermeer Parts Center. Use the reorder number on the front cover to order additional manuals.

Operating instructions are found in the T655III *Operator's Manual*. Lubrication and maintenance procedures are found in the T655III *Maintenance Manual*. Refer to "Reference Publications," for ordering information.

NOTE: Bleeder tabs located at the edge of the page aid in quickly locating information.

Reference Publications

Vermeer Publications

The following Vermeer Manufacturing Publications are necessary for reference:

- T655III Operator's Manual, 105400Z56, cabled assembly order no. 627301001
- T655III Maintenance Manual, 105400Z58
- T655III Tractor Parts Manual, 105400ZCL
- T655III Trencher Parts Manual, 105400L71

Contact the Vermeer Parts Center to order these publications.

Vendor Publications

The following vendor publications are optional reference materials:

- John Deere Engine Service Manual

Contact the appropriate local dealer for this information. Vermeer Manufacturing Company does not verify the validity of vendor information within the context of the T655III machine configuration.

WARRANTY CONSIDERATIONS

Vermeer Warranty

Vermeer's 1 year warranty is printed inside the front cover of the T655III Trencher *Operator's Manual*. The warranty requires that all service work be conducted by an authorized Vermeer representative or the warranty shall become void.

John Deere Warranty

The engine is covered under **John Deere's Warranty**.

Understand that only an authorized John Deere Service Facility may work on the engine while the warranty is in effect. Unauthorized service on the engine will void the warranty.

For the nearest John Deere authorized facility, consult the Yellow Pages of the phone directory or contact John Deere's Engine Warranty Service Dept.

SAFETY

General safety messages appear in this Safety section of the manual. Specific safety messages are located in the applicable sections of the manual where a potential hazard may occur if the instructions or procedures are not followed.

A signal word "**DANGER**", "**WARNING**", or "**CAUTION**" is used with the safety alert symbol.

Safety signs with signal word "**DANGER**", "**WARNING**", or "**CAUTION**" are located near specific hazards.

DANGER: Imminent hazards which, if not avoided, will result in serious personal injury or death.

WARNING: Potential hazards or unsafe practices which, if not avoided, could result in serious personal injury or death.

CAUTION: Potential hazards or unsafe practices which, if not avoided, could result in minor personal injury or product or property damage.

Do Not Modify Machine

Make no modifications to your equipment unless specifically recommended by Vermeer Manufacturing Company.

Maintain Operator Presence System

This machine is equipped with an Operator Presence system. This system is intended for your safety and must be maintained in good, functional condition.

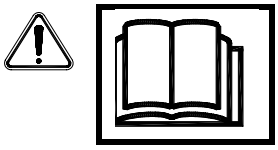
Replace Shields

Be sure that all safety devices, including shields, are installed and functioning properly after servicing the machine.

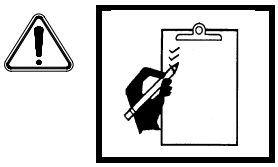
Safety Symbol Explanation



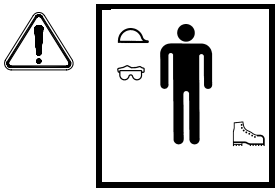
This is the safety alert symbol. This symbol is used in combination with an exclamation mark or other symbols to alert you to the potential for bodily injury or death.



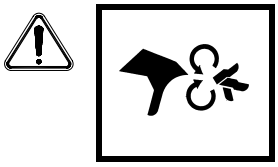
Read Operator's Manual and safety signs before operating machine. Allow only responsible, properly instructed individuals to operate and service the machine.



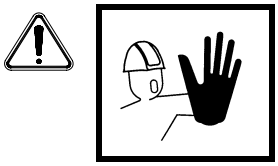
WARNING: Check machine before operating. Machine must be in good operating condition and all safety equipment installed and functioning properly.



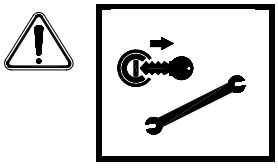
WARNING: Wear personal protective equipment. Wear close-fitting clothing and confine long hair. Avoid wearing jewelry such as rings, wristwatches, necklaces, or bracelets. Always wear a hard hat, safety glasses, and safety shoes.



WARNING: Keep hands, feet, and clothing away from power-driven parts. Keep shields in place and properly secured.



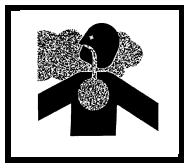
WARNING: Keep spectators away.



WARNING: Use Shutdown Procedure before servicing, cleaning, repairing, or transporting machine. Refer to *Shutdown Procedure*, page **2-1** for instructions.



WARNING: Pressurized fluid can penetrate body tissue and result in serious injury or death. Leaks can be invisible. Keep away from any suspected leak. Relieve pressure in the hydraulic system before searching for leaks, disconnecting hoses, or performing any other work on the system. If you must pressurize the system to find a suspected leak, use an object such as a piece of wood or cardboard rather than your hands. When loosening a fitting where some residual pressure may exist, slowly loosen the fitting until oil begins to leak. Wait for leaking to stop before disconnecting the fitting. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.



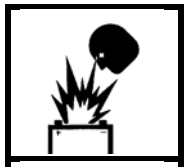
WARNING: Exhaust fumes can be fatal.

If operating in an enclosed area, remove the exhaust fumes with an exhaust pipe extension to the outside.

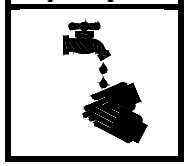


WARNING: Raised equipment can fall.

Never work under raised equipment unless it is adequately supported to prevent it from falling.



WARNING: Batteries produce an explosive gas when in use or being charged.
Wear protective clothing and face shield while working around batteries. Do not smoke, and keep flames and spark away from the battery area.



WARNING: Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the state of California to cause cancer and reproductive harm. Wash hands after handling.

WARNING: Failure to follow any of the preceding safety instructions or those that follow within this manual, could result in serious injury or death. This machine is to be used only for those purposes for which it was intended as explained in the Operator's Manual.

TERMINOLOGY

System

The term system refers to the entire machine and comprises all subsystems and individual circuits involved in all the machine functions.

Subsystem

A subsystem is usually responsible for a specific function. Each subsystem has its own circuits and components listed inside each rectangle of the system MAP, designed to enable that function to operate. The intent of the subsystem approach is to aid the service technician in isolating circuits and components for troubleshooting, and repairing a faulty system, returning it to service as quickly as possible.

Circuit

An identifiable grouping of components that fill a specific role within a subsystem.

MAP (Machine Analysis Page)

NOTE: MAPs (machine analysis pages) are simple diagrams used to illustrate the logical interdependencies between the mechanical, electric, and hydraulic inputs and outputs of a subsystem or complete machine system.

Inputs and Outputs

Inputs and outputs are shown on the MAPs' and other functional diagrams by different line styles classified as hydraulic, electrical, pneumatic, and mechanical. Arrows on the end of the lines represent direction of electrical current flow, hydraulic oil flow, and air flow.

Reference Designators

Reference Designators are assigned to each component shown on the maps and other reference diagrams. The functional diagrams addendum in the back of the manual includes a legend describing the reference designators and symbols and how they are used in the subsystem diagrams and text.

Each code-like designator identifies a specific component. The designator is comprised of an uppercase letter or letters followed by a number. The letters identify the type of component and the number specifies the exact component. In some cases an A-number will precede the designator for the component. The A-number identifies an assembly that holds the component.

Diagrams and Schematics

Functional diagrams, including maps, schematics, wire harness connections, and hydraulic hose connections, are located throughout the theory and troubleshooting sections. The diagrams represent subsystem circuitry and components. Large format schematics and diagrams are located in the addendum section in the back of manual. See the following Chapter Organization, sections, and Addendum and what material they conatain.

Chapter Organization

Other than this general and the system information (chapters 1 and 2), the manual is divided up into chapters based on the following subsystems:

Chapter 3 The Power Distribution subsystem consists of electrical circuits and components that are common to all machine subsystems. These components are involved in the development and distribution of operating current required by the electrical system.

Chapter 4 The Fluid Conditioning subsystem consists of hydraulic components that are common to most machine subsystems. These components are involved in the supply, conditioning, and return of oil required by the hydraulic system.

Chapter 5 The Engine subsystem consists of the engine and associated systems. The electrical circuits of the subsystem are responsible for ignition/start-up, battery charging, and throttle control of the engine.

Chapter 6 The Implement subsystem consists of the circuits and components necessary to operate the machine leveling, track tilting, trench cleaner fold, trench cleaner shoe, trencher boom lift, conveyor fold, conveyor shift, and dirt drags.

Chapter 7 The Ground Drive subsystem consists of the circuits and components necessary for left and right track FORWARD and REVERSE propel functions.

Chapter 8 The Attachment subsystem consists of the circuits and components necessary to operate the trencher drive function.

Chapter 9 The Cross Conveyor subsystem consists of the circuits and components necessary to drive and control cross conveyor speed and shift.

Chapter 10 The Auxiliary subsystem consists of the circuits and components necessary for operating the optional crane, and coulter wheel functions.

Chapter 11 The Load/Return Conveyor subsystem consists of the circuits and components necessary for operating the optional loading conveyor.

Chapter 12 The Optional Cab Feature consists of the circuits and components necessary to operate the cab controls.

Each chapter will have a detailed table of contents preceding it and will be divided into three sections, theory, troubleshooting, and repair.

Continued on next page...

Theory

The theory sections are arranged starting with an overview to each subsystem. The overview consists of a subsystem MAP, a list of circuits and components, and a graphic depicting component locations.

Theory sections describe what happens when the controls are activated, and how components that comprise that subsystem will function together to achieve the desired work. Illustrations, along with the text, will aid in understanding how the subsystems work.

Troubleshooting

These sections describe how to test suspected faulty circuits and positively determine which components are faulty.

Repair

When it is determined through troubleshooting that components are malfunctioning, the repair sections contain detailed instructions on how to repair or replace each component and any special steps or procedures needed before returning the machine to service.

Addendum

Reference materials such as complete machine electrical and hydraulic schematics as well as wire harness diagrams to large to fit on standard pages, are located in the Addendum in the back of this manual on 11 x 17″ foldouts.

TROUBLESHOOTING GUIDELINES

Problem-Solving Analysis

Situational analysis is the first step in servicing a machine to correct a malfunction. This involves critical scrutiny and analysis of a problem situation. It allows the troubleshooter to gain insight into an unacceptable condition. It is defined simply as looking at the overall condition of the machine functions and determining whether a problem even exists.

Perhaps there is no problem at all and it is an operating error. Perhaps the operator is not familiar with machine interlocks for which controls must be in the appropriate position to allow a certain function to perform. In other words, the operator may not thoroughly understand the theory of operation.

Analysis begins by asking questions and making observations as follows:

- Discuss the defect with the operator.
- Compare the problem with others from past experiences.

Continued on next page...

- Identify the existing state of operation, (unacceptable performance or complete failure), with a desired state, (normal or tolerable performance).
- Make an overall observation of the situation, noting symptoms and relevant changes.

Once the determination is made that a problem does exist, then further investigation is needed. The first step in problem solving is to get organized. Familiarize yourself with the service manual by reading all of the General and System Information chapters.

These chapters explain in detail how the machine is comprised of multiple separate subsystems and circuits as well as common subsystems that are shared by all.

If the technician is not familiar with, or has limited knowledge of the machine's functions, that person can read the theory of operation for all or selected subsystems.

NOTE: Do not skip analysis by jumping in and wasting a lot of time attempting to repair or replace a component, when simply reading the service manual information could easily have solved the problem.

Begin troubleshooting by doing the following:

- Describe and compare the problem situation with known operating conditions prior to breakdown.
- Describe all known differences such as symptoms, noises, and smells noticed when the failure occurred.
- Compare the "what is" with the "what is not". Note what subsystems/ circuits appear to be normal and which do not.

Fault Charts

When the troubleshooter has done the problem-solving analysis and noted their findings, based on observations, they can refer to the troubleshooting fault charts located in the beginning of each subsystem troubleshooting section and logically determine which circuits to investigate.

The charts list all the subsystem circuits and direct the troubleshooter to pages where appropriate troubleshooting procedures for each can be found.

Continued on next page...

NOTE: The troubleshooting procedures in this manual cover the electrical and hydraulic circuits. Proceed with the troubleshooting procedures only after first ensuring that a mechanical failure has not caused the machine to fail.

NOTE: The Implement subsystem circuits share a common hydraulic pump and control valve assembly. If multiple circuits within the implement subsystem fail, these shared components should be investigated first.

All subsystems with hydraulic circuits share the Fluid Conditioning components. If all of those subsystems experience related problems, these components should be investigated.

Electrical Troubleshooting

Common Electrical Problems

Listed below are some common problems to consider when troubleshooting the electrical circuits:

- **Ground**

Characteristic of ground problems can be no circuit or component function or intermittent function. Ground problems can be blamed for about 50% of all electrical problems.

- **High Resistance**

A characteristic of unwanted high resistance is lower than normal circuit current. Higher than normal resistance in a circuit will result in a lower than normal circuit current. This can be caused by loose, corroded, or oily terminals and connections on wire and cables, broken strands in a wire, or a poor ground connection.

Measurements taken with a multimeter can be used to troubleshoot for unwanted resistance. Use the meter to test for lower than normal battery voltage (voltage drop) while moving to accessible points in the circuit wiring.

Continued on next page...

- **Open Circuit**

Characteristics of an open circuit are zero current, infinite resistance, and higher than normal voltage. An open circuit can be found either on the voltage side or the ground side of a circuit. If there is an open anywhere in the circuit, the current path is broken and current will cease to flow through the circuit.

An open circuit can occur when a component fails internally, a wire or cable is broken or burned through or becomes detached, or when pins inside a connector do not make contact.

In a normal working circuit, voltage is applied to the resistive load where it is dropped proportionately over each resistor in the circuit. The amount of voltage drop is dependent on the value of each resistor. Open circuits cannot drop voltage.

Although, troubleshooters may find full battery voltage all the way to the open part of the circuit. Full battery voltage can also be found on the ground side of the circuit if the circuit is open near the battery negative terminal.

Measurements taken from a multimeter can be used to troubleshoot an open circuit. Use the meter to test for voltage while moving to accessible points in the circuit to find the open and isolate the failed component or wire harness section.

- **Short Circuit**

Characteristics of a short circuit are higher than normal current, and zero resistance. A short circuit, can be caused by a component being subjected to heat, vibration, and so on as it ages. Over time this can cause abrasions in the insulation on coils and wires and such. Exposed wires can provide a short path for current reducing the resistance that was designed into the circuit(s).

As resistance lowers, the current will increase to a level higher than the circuit fuse was designed to handle, resulting in a blown fuse. The source of the short must be fixed or the fuse will continue to blow.

Hydraulic Troubleshooting

Leakage Path Analysis

The hydraulic troubleshooting procedures are based on leakage path analysis. Using these methods, components are tested under no-load then full-load. The measurements taken from the test equipment are compared to the standard specifications and tolerances listed in the (analyzing test results) located at the end of the troubleshooting test procedures.

NOTE: Opening a closed-loop hydrostatic system is not recommended to perform test. The threat of introducing contamination is too high. The closed-loop hydrostatic procedures are used to check the motor case drain leakage. This test will reveal the overall condition of a closed-loop system.

High leakage will cause system overheating and/or a decline in actuator (cylinder or motor) speed. The amount of leakage is influenced by four factors:

- pressure difference across clearances
- oil viscosity
- temperature
- size of clearances

NOTE: Clearance related problems are generally viscosity sensitive. Increased leakage will be less obvious when the fluid temperature is low and will increase as the fluid temperature increases.

Pumps and Motors

As pressure in a hydraulic system increases, the internal leakage of hydraulic components, especially pumps and motors, increases. This results in a decreased output flow.

Pumps and motors have component parts which move in relation to one another, separated by a small oil-filled clearance. These components are generally loaded toward one another by forces related to system pressure, surface area, and springs or seals. Over time these components become worn and clearances become larger than their rated specifications.

Theoretically, a pump delivers an amount of fluid equal to its displacement during each revolution. The actual output is reduced because of internal leakage. As pressure increases, the leakage also increases causing a decrease in output flow.

Theoretically, a motor rotates at a speed equal to its displacement during each revolution. The actual speed is reduced because of internal leakage (reduced flow). As the pressure difference across motor increases, leakage also increases causing a proportional decrease in motor shaft speed.

Continued on next page...

The most common symptoms associated with excessive pump/motor leakage are:

- A loss of actuator speed as the fluid temperature increases.
- A moderate to high increase in the operating temperature of the fluid.
- Actuator stalling at low pump or motor speed.
- Increase in case pressure which could result in shaft seal leakage.

NOTE: If leakage in a pump or motor approaches or exceeds 30% of the theoretical (no-load) flow at full-load (maximum rated pressure) it should be replaced.

Any increase in internal leakage will result in increased flow into case drain lines of externally drained pumps and motors. If case drain flow increases, case pressure will increase because of higher flow resistance through drain port in the housing and case drain lines. Excessive case pressure could result in shaft seal failure and case seal leakage.

The most common symptoms associated with excessive pump/motor case pressure are:

- Shaft seal leakage
- Catastrophic shaft seal failure
- Case seal leakage
- Moderate to high increase in the operating temperature of the fluid

Directional Control Valves

Directional control valves have radial clearances between the valve bore and spool of between 5 to 15 micrometers. If fluid is heavily contaminated with particles which are equal in size to the clearances between spool and bore, it will cause abrasive wear. Abrasive wear will gradually increase the radial and diametrical clearances, resulting in increased cross-port leakage.

The most common symptoms associated with excessive directional control valve leakage are:

- Increased actuator drifting while directional control valve is in the NEUTRAL position.
- Moderate to high increase in the operating temperature of the fluid.
- Loss of precise position control.

Continued on next page...

Cylinders

Hydraulic cylinders consist of a moveable piston and rod assemblies. Pistons have seals to prevent leakage across the piston.

The most common symptoms associated with excessive cylinder leakage are:

- Cylinder fails to respond when directional control valve is actuated.
- Reduced cylinder rod speed in one or both directions of travel.
- Moderate to high increase in the operating temperature of the oil.
- Cylinder rod speed reduction as the load increases.
- Actuator drifts the directional control valve is in neutral position.
- Cylinder rod extends regardless of which port the oil enters.

Required Tools

- Digital multimeter—for performing voltage, current and resistance tests
- Calculator—for doing simple arithmetic quickly and accurately
- Pyrometer or thermometer with a magnetic base—for temperature readings
- Pressure gauges—for measuring system pressure
- Vacuum gauge—for measuring inlet pressure
- Flow meter—for measuring system flow
- Needle valve—for imposing an artificial load

Hydraulic Connections





WARNING: Pressurized fluid can penetrate body tissue and result in serious injury or death. Leaks can be invisible. Keep away from any suspected leak. Relieve pressure in the hydraulic system before searching for leaks, disconnecting hoses, or performing any other work on the system. If you must pressurize the system to find a suspected leak, use an object such as a piece of wood or cardboard rather than your hands. When loosening a fitting where some residual pressure may exist, slowly loosen the fitting until oil begins to leak. Wait for leaking to stop before disconnecting the fitting. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

Avoid Trapped Pressure

Never disconnect hoses or lines unless the engine is shutdown, and the pressure in the circuit is relieved.

Avoid Oil Contamination

Warranty claims may be denied if damage is caused by contaminated hydraulic fluid.

Use care to avoid allowing dirt, dust or debris to enter the hydraulic system. Contaminated oil will ruin a pump in a short amount of time.

- Clean dirt from hose connections before loosening any connection.
- Use new, clean plugs to plug disconnected hoses. If clean plugs are not available, place plastic bags (such as sandwich bags) over the ends of hoses and hold them in place with rubber bands.
- When adding oil, use new oil filtered through a 10-micron absolute filter. (New oil is full of particles from metal storage containers and is not intended to be added directly to the hydraulic tank.)

Connecting Flow Meters

Flow meters measure flow in one direction only. An arrow on the flow meter indicates the direction. The test setup instructions will state which way the flow arrow must point.

Often, adapters will be needed to plumb the flow meter into the line. It's important that the flow through the meter is not restricted (unintentionally) by using a flow meter or adapters that are of smaller diameter than the hose. Use a larger diameter flow meter if needed, and use adapters to connect the smaller diameter hose to the larger diameter flow meter.

Use a flow meter that is rated to safely withstand the pressure in the circuit.

Connecting A Needle Valve

Needle valves are used to impose artificial loads on pumps so the performance of the pump can be accurately measured. By slowly closing the needle valve while watching the pressure gauge, you can easily set the pressure as needed for the flow measurement.

As with flow meters, you can safely use a larger diameter needle valve, but you must not use smaller diameters.

NOTE: Do **not** attempt to use a ball valve in place of a needle valve. The ball valve is not precise and tends to snap closed by itself when higher pressures are reached. This will send a destructive pressure spike back through the system.

Use a needle valve that is rated to safely withstand the pressure in the circuit.

Connecting Pressure Gauges

Pressure gauges are selected according to the expected maximum pressure to be observed during the test. Since the gauge is most accurate at the middle of its range, read through the test to determine the expected maximum pressure and double that amount. Thus, if you expect to see 3000 psi as the greatest pressure during the test, select a 6000 psi gauge.

IMPORTANT: If the gauge ever sees more pressure than it's rated for, the gauge is ruined. Discard it immediately so that another technician doesn't use it and receive erroneous readings.

Thermometer or Pyrometer

The magnetic-base thermometer is placed on the oil tank to determine the temperature of the oil. Allow time for the thermometer to react before taking a temperature reading.

The pyrometer is a non-contact thermometer. Place the projected red dot on the surface and wait at least one second. The temperature of the surface is shown in the indicator window.

Several readings may be required during the same test. It is important to take the readings with the projected dot focused on the same spot on the surface.

Digital Multimeter

The multimeter is used to measure voltage, current, and resistance. It is also used to test wires for continuity .

Measuring Voltage

Voltage is defined as a difference in electrical potential between two points. Ensure the multimeter is set to measure volts DC in the appropriate setting. (If needed, see the instruction booklet for your multimeter to determine proper settings.) Then do the following:

1. Turn off power to the circuit or device.
2. Connect positive (red) lead to the multimeter's voltage or VΩ port. Place red probe on the wire or contact delivering power to the device.
3. Connect negative (black) lead to the common or COM port. Place the black probe on the wire or contact leading to ground for the device. In some cases you may place the black probe on the metal structure of the vehicle chassis. (The multimeter is in parallel with the circuit.)
4. Turn on power to the device.

The multimeter will indicate the voltage available to power the device.

Measuring Resistance

Resistance, measured in Ohms (Ω) is defined as the opposition to current flow. Set the multimeter to measure resistance. (If needed, see the instruction booklet for your multimeter to determine proper settings.) Then do the following:

1. Turn off power to the circuit or device.
2. Connect positive (red) lead in the multimeter's voltage or VΩ port. Place red probe on the wire or contact delivering power to the device.
3. Connect negative (black) lead in the common or COM port. Place black probe on the wire or contact leading to ground for the device. (The multimeter is in parallel with the circuit.)

The multimeter sends a small current through the device and indicates the amount of resistance encountered. Resistance (Ohms or Ω) greater than or less than published tolerances indicates the device is damaged and should be replaced.

Testing for Continuity

Continuity is defined as the presence of a complete pathway for the flow of current. With the multimeter set to test continuity, do the following:

1. Turn off power to the device or circuit.
2. Disconnect the section of harness in question.
3. Place one probe on one end of the wire or terminal of the device. Place the other probe on the other end of the same wire or opposite terminal of the same device.

An indication of zero or very low resistance (Ohms or Ω), indicates continuity (good wire or closed switch). High resistance or an indication of “OL” (overload) means there is no electrical contact between the two probes, i.e., the wire is broken or the switch is open. In this manual, the results of a continuity check are described as “continuity” or “open.”

Some multimeters or continuity testers produce a beep or illuminate a bulb to indicate continuity.

Measuring Current

Current, or amperage is defined as the flow of electrons. Set the multimeter to measure amps DC or milliamps DC. (If needed, see the instruction booklet for your multimeter to determine proper settings.) This involves plugging the leads to the proper ports in the multimeter and setting the knobs and/or range switches correctly for measuring the expected amount of current (microamps, milliamps or amps). Then do the following:

1. Turn off power to the circuit or device.
2. Unplug the device from the wiring harness and install the proper breakout box or a test harness.
3. Disconnect the exposed connector for the desired wire.
4. Place red probe on one of the exposed connectors for the wire.
5. Place black probe on the other exposed connector for the wire. (The multimeter is in series with the circuit.)
6. Turn on the power to the device.

The multimeter indicates the current in amps (A), milliamps (mA) or microamps (µA).

Shop Requirements

Special Tools and Test Equipment

To perform some tasks, special tools— available through Vermeer—may be required. These tools, are specified at the beginning of the procedure where they are needed.

Refer to the Recommended Service Tools Users Guide (Vermeer P/N 105400T69) for special tools and test equipment.

Personnel and Lifting Requirements

Review each task to determine the number of personnel needed for ***safe*** completion.

Determine if suitable lifting devices are needed to safely lift or lower the component.

Replacement Parts

Part Numbers/Hose Lengths/Fitting Orientation

Refer to the most current **T655III Parts Manual,** P/N 105400ZKJ and 105400ZKK for part numbers, hose lengths, and fitting orientations.

Parts Ordering

Contact the Vermeer Parts Center with part number information to order replacement components.

Torque Tables

Dynamic vs. Static Torque

The following charts often list values for dynamic and static torque.

The **dynamic** value is used when assembling the fittings. Whenever possible use a torque wrench to achieve the dynamic torque value given in the chart.

The **static** torque value is used to ensure an assembled fitting is correctly torqued. Set the torque wrench for the value and attempt to loosen the fitting. It should not loosen before the static torque value is reached.

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Flats After Finger-Tight

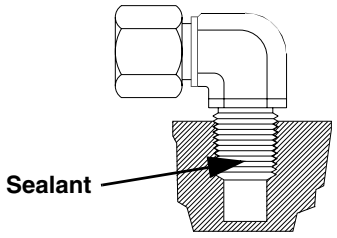
Some charts also list a “Flats after Finger-Tight” value. If no torque wrench is available, you can tighten the fitting as tightly as possible bare-handed, then use a wrench to turn it the additional numbers of flats given. Each flat equals 1/6 of a full revolution of the nut.

NOTE: If at all possible, use a torque wrench to ensure proper torque. The “Flats...” method is intended only as a short-term fix to get the machine running. Later, return with a torque wrench and check the static torque of the fitting to ensure it is secure.

Pipe Thread Fittings

Pipe thread fittings may be either straight or tapered, and coarse thread or fine thread. The critical factors for a pipe thread fitting are:

- its ability to seal
- its ability to be disassembled again, after the sealant has set



CAUTION: Increasing torque may improve sealing ability up to a point, but too much torque will damage threads and ruin the fittings.

The chart is for use with tapered pipe thread fittings, both fine thread (NPTF) and coarse thread (NPT) where both the male and female fittings are tapered and both are made of ferrous metals.

NOTE: Sometimes, commonly with grease fittings, a straight thread fitting will be joined to a tapered thread fitting. In these cases, use only 50% of the torque value given in this chart.

NOTE: Also, for non-ferrous fittings, use only 50% of the torque value given in this chart.

Make sure the threads are free from nicks, burrs, dirt or damage.

IMPORTANT: Use a thread sealant, not pipe dope or Teflon tape. Teflon tape can plug filters, drain orifices or ports and cause hydraulic system failures.

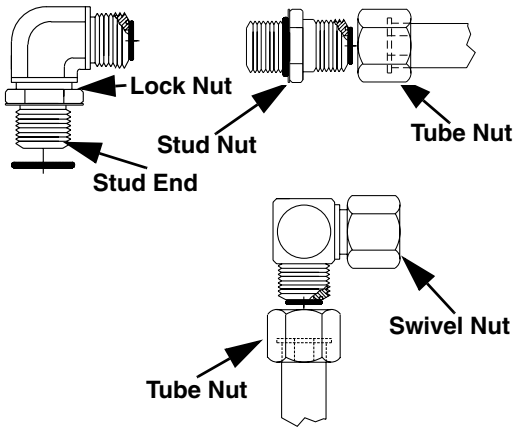
Size inch	Thread per in.	Torque with sealant		Torque w/o sealant	
		ft-lb	Nm	ft-lb	Nm
1/16	27	7	10	7	10
1/8	27	12	16	12	16
1/4	18	15	20	18	25
3/8	18	26	35	33	45
1/2	14	33	45	44	60
3/4	14	44	60	55	75
1	11.5	55	75	66	90
1-1/4	11.5	70	95	81	110
1-1/2	11.5	81	110	96	130
2	11.5	96	130	118	160

Face Seal Fittings with O-Rings

O-ring fittings are not tapered.

Lubricate the O-ring with a light coat of oil and torque to the value given in this chart (unless a different torque value is given in the text for the procedure).

Values are given for both ends of the fitting.

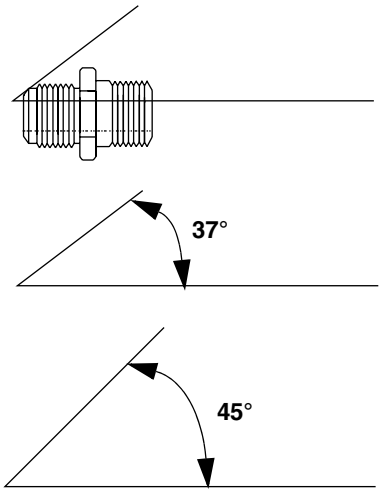


Tube OD or Hose ID			Face Seal Tube or Hose End of Fitting							
mm	Dash size	inch	Thread Diameter	Threads per inch	Tube Nut or Swivel Nut Torque					
					Min		Target		Max	
					ft-lb	Nm	ft-lb	Nm	ft-lb	Nm
6	-4	1/4	9/16	18	10	13	12	16	14	19
10	-6	3/8	11/16	16	14	19	18	24	21	29
12	-8	1/2	13/16	16	30	40	37	50	44	60
16	-10	5/8	1	14	41	55	50	69	61	83
22	-14	7/8	1-3/16	12	61	82	75	102	89	122
25	-16	1	1-7/16	12	84	114	105	142	125	170
32	-20	1-1/4	1-11/16	12	112	152	140	190	168	228
38	-24	1-1/2	2	12	129	174	160	217	191	260

Tube OD or Hose ID			O-Ring End of Fitting							
mm	Dash size	inch	Thread Diameter	Threads per inch	Straight Fitting or Lock Nut Torque					
					Min		Target		Max	
					ft-lb	Nm	ft-lb	Nm	ft-lb	Nm
5	-3	3/16	3/8	24	5	6	6	8	7	10
6	-4	1/4	7/16	20	8	10	9	12	10	14
8	-5	5/16	1/2	20	10	13	12	16	14	19
10	-6	3/8	9/16	18	14	19	15	21	18	24
12	-8	1/2	3/4	16	28	37	34	46	40	55
16	-10	5/8	7/8	14	37	50	46	62	54	74
22	-14	7/8	1-3/16	24	73	98	90	122	107	146
25	-16	1	1-5/16	12	84	114	105	142	125	170
32	-20	1-1/4	1-5/8	12	112	152	140	190	168	228
38	-24	1-1/2	1-7/8	12	129	174	160	217	191	260

Flare Fittings

There are two flare fittings that may be used and the torque values for them are different. The fittings have the angle of the mating face of the male fitting at either 45° or 37° to the internal bore of the fitting.



These are metal to metal fittings that rely on the convex surface on the male fitting nesting tightly to, and slightly expanding the concave surface in the female fitting.

Both the male and female fittings must have the same angle (37° or 45°).

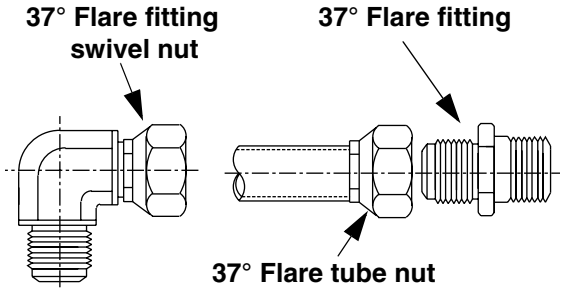
The 37° fittings are used in hydraulic systems and made of steel to withstand those pressures.

The 45° fittings are usually made of brass and are used in systems with much lower pressures, such as brake lines.

37° Flare JIC Tube Nuts & Swivel Nuts

The female fitting (nut) expands slightly when tightened to form a seal against the 37° flared surface on the male fitting.

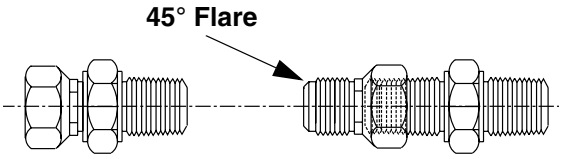
NOTE: Overtightening the fitting may deform or break the female side of the fitting, restricting oil flow or causing a leak.



Tube OD			Threads		Dynamic Torque						Static Torque		Flats after finger tight	
					Min		Target		Max					
mm	Dash size	inch	Diameter	# per inch	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	New nut	Used Nut
3	-2	1/8	5/16	24	3	4	4	5	4	6	2	3		
5	-3	3/16	3/8	24	7	11	8	11	9	13	6	8		
6	-4	1/4	7/16	20	9	12	12	16	14	20	9	11	2	1
8	-5	5/16	1/2	20	12	15	15	20	18	25	10	14	2	1
10	-6	3/8	9/16	18	15	20	18	25	22	30	14	18	2	1
12	-8	1/2	3/4	16	32	43	37	50	42	57	28	38	1.5	1
16	-10	5/8	7/8	14	43	58	48	65	53	72	39	52	1.5	.75
19	-12	3/4	1-1/16	12	67	90	74	100	81	110	59	80	1.5	.75
22	-14	7/8	1-3/16	12	82	110	88	120	95	130	73	99	2	1.25
25	-16	1	1-5/16	12	89	120	100	135	103	140	82	110	1.5	1
32	-20	1-1/4	1-5/8	12	122	165	133	180	144	195	111	150	1.5	1
38	-24	1-1/2	1-7/8	12	155	210	166	225	177	240	140	190	1.5	1
51	-32	2	2-1/2	12	214	290	234	320	243	330	192	260	1.5	1

45° Flare Fittings

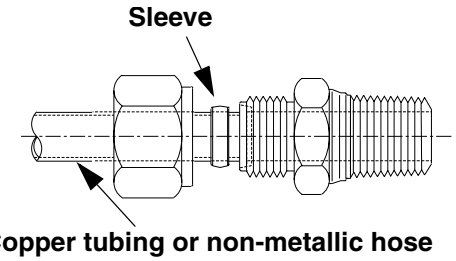
The female fitting (nut) expands slightly when tightened to form a seal against the 45° flared surface on the male fitting.



Tube OD			Threads		Dynamic Torque						Static Torque	
					Min		Target		Max			
mm	Dash size	inch	Diameter	# per inch	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm
3	-2	1/8	5/16	24	3	4	4	5	5	7	3	3
5	-3	3/16	3/8	24	6	7	6	8	7	10	5	6
6	-4	1/4	7/16	20	7	9	8	11	9	13	6	8
8	-5	5/16	1/2	20	11	14	13	17	14	20	10	13
10	-6	3/8	5/8	18	20	27	22	30	24	33	19	25
11	-7	7/16	11/16	16	20	27	22	30	24	33	19	25
12	-8	1/2	3/4	16	25	34	28	38	30	42	23	30
16	-10	5/8	7/8	14	34	45	37	50	40	55	30	40
19	-12	3/4	1-1/16	12	61	82	66	90	72	98	56	75
22	-14	7/8	1-1/4	12	67	90	74	100	81	110	59	80

Air Brake Fittings

These fittings seal by compressing a small, soft metal sleeve (encircling the air line) between the female (nut) and male parts of the fitting. Inspect the sleeve, as well as the threads for foreign matter and nicks.



Air brake lines may be hoses or copper tubing. The torque values are the same for both types of line.

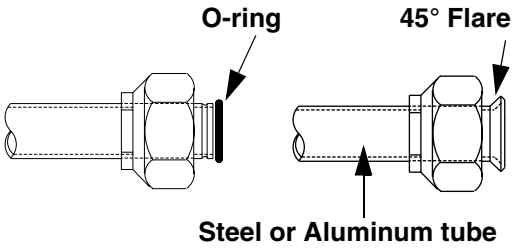
The different columns for a new or used fitting refer to the female fitting (nut). (Note that the numbers of flats are different between copper and non-metallic tubing.)

Tube OD			Dynamic Torque						Static Torque		Flats after finger tight	
			Min		Target		Max					
mm	Dash size	inch	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	Non-metallic Line	Copper Tubing
6	-4	1/4	6	8	8	11	10	14	4	5	3	2
10	-6	3/8	13	17	15	20	16	23	9	11	4	2
12	-8	1/2	22	29	26	35	30	41	14	19	4	2
16	-10	5/8	25	34	29	40	33	46	17	22	3.5	3
19	-12	3/4	33	44	37	50	41	56	22	29	3.5	3

Air Conditioning Fittings

Some fittings employ an O-ring seal, others use a 45° flare for a metal-to-metal seal.

The 45° flare fittings may be used on steel tubing or aluminum tubing. There are different torque settings for O-ring vs. 45° flare and steel vs. aluminum tubing.



O-Ring Fittings

Threads		Dynamic Torque						Static Torque	
		Min		Target		Max			
inch	per inch	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm
5/8	18	8	10	10	14	13	18	8	10
3/4	16	17	23	20	27	22	31	15	26
7/8	14	27	36	29	40	32	44	23	31
1	14	27	36	29	40	32	44	23	31
1-1/16	14	30	40	33	45	36	44	27	31

45° Flare Fittings in Steel Tubes

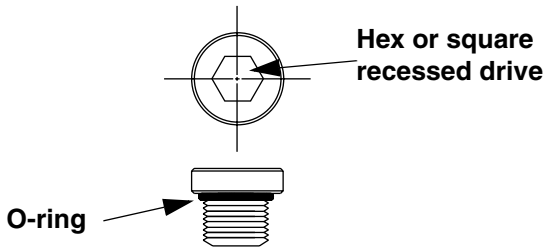
Threads		Dynamic Torque						Static Torque	
		Min		Target		Max			
inch	per inch	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm
5/8	18	20	27	22	30	24	33	18	24
3/4	16	35	47	38	52	42	57	31	42
7/8	14	39	53	44	60	49	67	37	49
1	14	39	53	44	60	49	67	37	49
1-1/16	14	50	67	55	75	61	83	43	60

45° Flare Fittings in Aluminum Tubes

Threads		Dynamic Torque						Static Torque	
		Min		Target		Max			
inch	per inch	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm
5/8	18	15	20	17	23	19	26	14	18
3/4	16	22	29	24	33	27	37	20	26
7/8	14	25	34	28	38	30	42	23	30
1	14	25	34	28	38	30	42	23	30
1-1/16	14	34	45	37	50	40	55	30	40

O-Ring Boss Plug

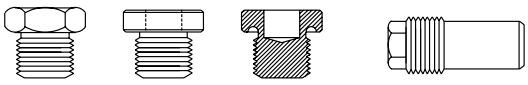
Use 50% of the given torque value when either the plug or the port is non-ferrous.



Tube OD			Threads		Dynamic Torque						Static Torque	
					Min		Target		Max			
mm	Dash size	inch	Dia	per inch	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm
3	-2	1/8	5/16	24	3	4	4	5	4	6	2	3
5	-3	3/16	3/8	24	7	11	8	11	9	13	6	8
6	-4	1/4	7/16	20	9	12	12	16	14	20	9	11
8	-5	5/16	1/2	20	12	15	15	20	18	25	10	14
10	-6	3/8	9/16	18	15	20	18	25	22	30	14	18
12	-8	1/2	3/4	16	32	43	37	50	42	57	28	38
16	-10	5/8	7/8	14	43	58	48	65	53	72	39	52
19	-12	3/4	1-1/16	12	67	90	74	100	81	110	59	80
22	-14	7/8	1-3/16	12	82	110	88	120	95	130	73	99
25	-16	1	1-5/16	12	89	120	100	135	103	140	82	110
32	-20	1-1/4	1-5/8	12	122	165	133	180	144	195	111	150
38	-24	1-1/2	1-7/8	12	155	210	166	225	177	240	140	190
51	-32	2	2-1/2	12	214	290	234	320	243	330	192	260

Drain Plugs

Use 50% of the given torque value when either the plug or the port is non-ferrous.



Type A | Type B | Type C | Type D conical seal - no gasket

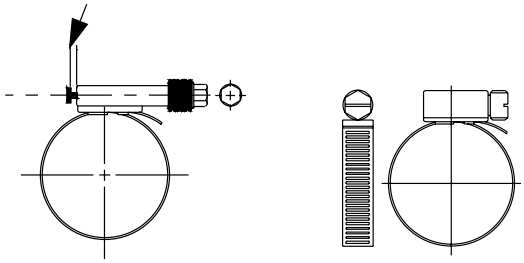
Type	Tube OD			Threads		Dynamic Torque						Static Torque	
	mm	Dash size	Inch	Diameter inch	per inch	Min		Target		Max			
						ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm
D	8	-5	3/16	1/2	20	6	7	8	11	11	15	6	7
A				1/2	30	11	15	15	20	18	25	11	14
A	10	-6	3/8	5/8	11	23	30	26	35	29	40	20	27
A				3/4	12	34	45	37	50	40	55	28	38
A	12	-8	1/2	3/4	16	34	45	37	50	40	55	28	38
D	16	-10	5/8	7/8	14	36	48	41	55	45	62	31	42
A	16	-10	5/8	7/8	14	41	55	52	70	62	85	37	50
A				1-1/8	12	41	55	52	70	62	85	37	50
C				1-1/8	12	41	55	52	70	62	85	37	50
D				1-3/8	12	56	75	66	90	77	105	52	70
D				1-1/2	12	70	95	81	110	92	125	59	80
B				1-1/2	12	56	75	66	90	77	105	52	70
B	38	-24	1-1/2	2	12	82	110	92	125	103	140	67	90

Hose Clamps

Constant Torque Hose Clamp

There is no chart needed for this clamp. It is correctly torqued when the Belleville washers are compressed nearly flat and the tip of the screw extends 1/4″ (6.4 mm) from the housing.

.25″ (6.4 mm) at 8 ft-lb (11 Nm)



Constant Torque type | Band type

Band Type Hose Clamp

The hose will compress under the clamp relieve some of the tightness of the clamp. The compress portion will not fully expand if the clamp is removed. Thus, different torque values apply when reinstalling a clamp on an existing hose rather than install the clamp on a new hose.

Wait one hour or more after the clamp is installed before checking the static torque to allow the hose to compress and the clamp to stretch.

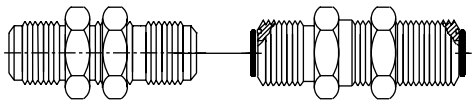
Band Type Hose Clamps

Band width		Dynamic Torque on New Hose						Static Torque	
		Min		Target		Max			
mm	inch	in-lb	Nm	in-lb	Nm	in-lb	Nm	in-lb	Nm
16	5/8	70	7	66	7.5	70	8	36	4
14	17/32	36	4	40	4.5	44	5	18	2
8	5/16	6	0.7	8	0.9	9	1.1	5	0.5

		Dynamic Torque on Used Hose					
		Min		Target		Max	
		in-lb	Nm	in-lb	Nm	in-lb	Nm
16	5/8	36	4	40	4.5	44	5
14	17/32	22	2.5	27	3	30	3.5
8	5/16	5	0.5	6	0.7	7	0.9

Bulkhead Nut

Use 50% of the given torque value when either the plug or the port is non-ferrous.



Tube OD			Threads		Dynamic Torque						Static Torque	
					Min		Target		Max			
mm	Dash size	inch	Dia	per inch	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm
6	-4	1/4	9/16	18	4	5	5	7	6	9	3	3.5
10	-6	3/8	11/16	16	9	11	10	13	11	15	6	7
12	-8	1/2	13/16	16	16	21	17	23	18	25	10	13
16	-10	5/8	1	14	23	30	24	33	26	36	14	19
22	-14	7/8	1-3/16	12	30	40	33	45	36	50	19	25
25	-16	1	1-7/16	12	43	60	48	65	51	70	29	40
32	-20	1-1/4	1-11/16	12	59	80	64	87	69	94	37	50
38	-24	1-1/2	2	12	70	95	77	105	84	115	45	60

SAE Grade 2, Grade 5, and Grade 8 Cap Screws and Bolts

Torque values specified in text take precedence over values shown below. These values do not apply when used with lock nuts.

	Grade 2 		Grade 5 		Grade 8 	
Bolt Size	**ft-lb**	**Nm**	**ft-lb**	**Nm**	**ft-lb**	**Nm**
1/4 - 20 NC	4	5	6	8.5	10	13
1/4 - 28 NF	5	6	8	11	11	15
5/16 - 18 NC	9	12	13	18	20	27
5/16 - 24 NF	10	13	15	20.5	22	29.5
3/8 - 16 NC	16	22	25	35	35	47
3/8 - 24 NF	18	24	30	40	40	55
7/16 - 14 NC	25	35	40	55	55	75
7/16 - 20 NF	30	40	45	60	65	88
1/2 - 13 NC	40	55	60	80	90	120
1/2 - 20 NF	45	60	70	95	95	130
9/16 - 12 NC	55	75	90	120	120	165
9/16 - 18 NF	60	80	95	130	135	185
5/8 - 11 NC	75	100	120	165	180	245
5/8 - 18 NF	80	110	145	200	195	265
3/4 - 10 NC	130	175	210	285	300	405
3/4 - 16 NF	145	200	240	325	340	460
7/8 - 9 NC	150	205	320	435	500	680
7/8 - 14 NF	170	230	350	475	560	760
1 - 8 NC	180	245	480	650	800	1085
1 - 12 NF	200	270	560	760	920	1250
1 1/8 - 7 NC	240	325	700	950	1180	1600
1 1/8 - 12 NF	275	375	780	1060	1340	1815
1 1/4 - 7 NC	340	460	1020	1385	1720	2330
1 1/4 - 12 NF	370	500	1140	1545	1900	2575
1 3/8 - 6 NC	460	625	1360	1845	2280	3090
1 3/8 - 12 NF	540	730	1580	2140	2620	3550
1 1/2 - 6 NC	640	870	1840	2495	3060	4150
1 1/2 - 12 NF	740	1000	2100	2850	3460	4690

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Metric Grade 5.8, 6.9, 8.8, 10.9, & 12.9 Cap Screws and Bolts

	Grade 5.8 		Grade 6.9 		Grade 8.8 		Grade 10.9 		Grade 12.9 	
Bolt Size	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm
M4	1.1	1.5	1.7	2.3	2	2.7	2.9	4	3.6	5
M5	2.3	3.1	3.5	4.7	4	5.4	6	8	7	9.5
M6	3.9	5.3	5.8	7.8	7	9.5	10	13.5	11	15
M7	6.5	8.8	9.4	12.7	11	15	16	22	20	27
M8	10	13.5	14	19	18	24	25	34	29	39
M10	20	27	29	39	32	43	47	64	58	79
M12	34	46	50	68	58	79	83	112.5	100	136
M14	54	73	79	107	94	127	133	180	159	216
M16	80	108.5	122	165	144	195	196	266	235	319
M18	114	155	170	230.5	190	258	269	365	323	438
M20	162	220	220	298	260	353	366	496	440	597
M22	202	274	318	431	368	499	520	705	628	852
M24	245	332	410	556	470	637	664	900	794	1077
M27	360	488	606	822	707	959	996	1351	1205	1634
M30	500	678	815	1105	967	1311	1357	1840	1630	2210

Grade B, C, F, and G Lock Nuts

	Grade B (Grade 5) 		Grade C (Grade 8) 		Grade F (Grade 5 Flange) 		Grade G (Grade 8 Flange) 	
Nut Size	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm
1/4 20 NC	7.5 - 10	10 - 13	10 - 14	14 - 19	8 - 10	11 - 14	12 - 16	16 - 21.5
1/4 28 NF	8 - 10	11 - 14	10 - 14	14 - 19	9 - 12	12 - 16	12 - 17	16 - 23
5/16 18 NC	14 - 17.5	19 - 24	17.5-22.5	24 - 30.5	15 - 20	20 - 27	19.5 - 27	27 -36
5/16 24 NF	15 - 18	20 - 25	18 - 23	25 - 32	16 - 22	21.5 - 29	19.5 - 26	27 - 35
3/8 16 NC	21 - 27	28.5 - 37	29 - 37	39 - 50	22.5-32.5	30.5 - 44	30 - 41	41 - 56
3/8 24 NF	27.5 - 38	37 - 51.5	22.5 - 31	30.5 - 42	23.5-31.5	32 - 43	31 - 42	42 - 57
7/16 14 NC	31 - 40	42 - 54	39 - 53	53 - 72	36 - 50	49 - 68	45 - 62	61 - 84
7/16 20 NF	39 - 51	53 - 69	41 - 56	56 - 76	38 - 53	51.5 - 72	51 - 71	69 - 96
1/2 13 NC	49.5-62.5	67 - 85	62 - 79.5	84 - 108	50.5-69.5	68.5 - 94	72 - 102	98 - 132
1/2 20 NF	50 - 65	68 - 88	67 - 87	91 - 118	56.5-78.5	77 - 106	67 - 106	91 - 144
9/16 12 NC	67 - 87	91 - 118	95 - 120	129 - 163	72 - 102	98 - 132	105 - 145	142 - 197
9/16 18 NF	74.5-94.5	101 - 128	95 - 120	129 - 163	79 - 111	107-150.5	113 - 157	153 - 213
5/8 11 NC	95 - 120	129 - 163	125-157.5	169.5-214	100 - 137	136 - 186	130 - 178	176 - 241
5/8 18 NF	97.5-122.5	132 - 166	125 - 160	169.5-217	105 - 145	142 - 197	150 - 210	203 - 285
3/4 10 NC	160 - 200	217 - 271	200 - 255	271 - 346	170 - 230	230.5-312	205 - 285	278-386.5
3/4 16 NF	155 - 200	210 - 271	200 - 255	271 - 346	163 - 227	221 - 308	215 - 315	291.5-427
7/8 9 NC	235 - 300	319 - 407	295-382.5	400 - 519				
7/8 14 NF	250 - 320	339 - 434	295-382.5	400 - 519				
1 8 NC	345 - 445	468 - 603	450-512.5	610 - 695				
1 12 NF	370 - 470	502 - 637	452.5-590	617 - 800				

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Chapter 2—System Information

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Chapter 2: System Information

Overview

SHUTDOWN PROCEDURE

When stopping the machine, use the following shutdown procedure:

Step 1: Place *Ground Drive Lever* in NEUTRAL.

Step 2: Engage *Park Brake*.

Step 3: Disengage power to all attachments.

Step 4: Lower all attachments to the ground.

Step 5: Reduce engine speed to idle.

IMPORTANT: Whenever practical and safe, idle engine for a minimum of five minutes before shutting down after operating at full power. This lengthens engine life and prevents turbocharger damage.

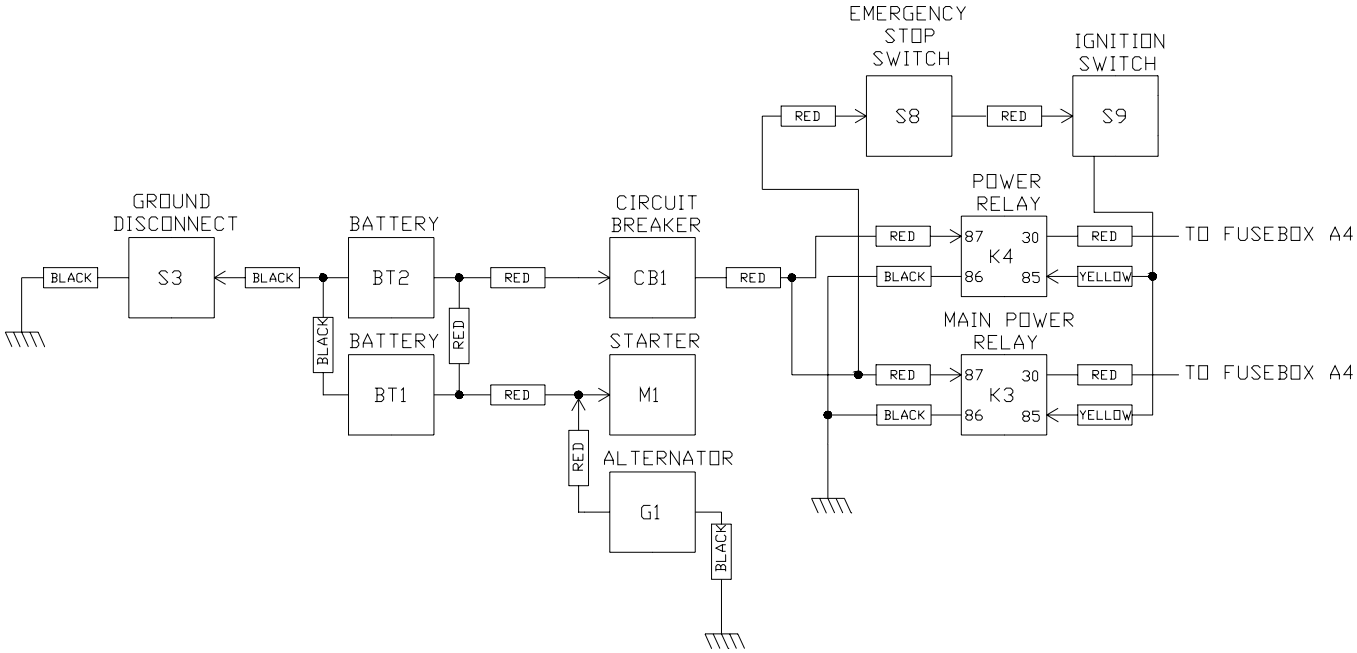
Step 6: Shut off engine and remove key.

For your safety and the safety of others, use the Shutdown Procedure before servicing, cleaning, inspecting, or transporting the machine.

NOTE: A variation of the above procedure may be used if so instructed within this manual or if an emergency requires it.

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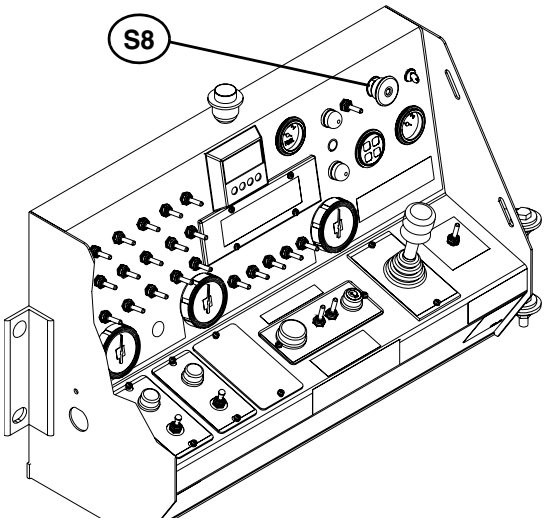
EMERGENCY STOP CIRCUIT



The emergency stop circuit utilizes switch S8 located on control console, When the switch is pushed, the normally closed switch will open, disconnecting supply voltage to the electrical system. Once the machine is disabled, the emergency stop switch must be reset.

Switch - Reset

1. Turn ignition key to OFF position.
2. Place all controls in NEUTRAL.
3. Remove or correct the cause for emergency stopping of machine.
4. Pull out (reset) *Emergency Stop switch* S8 on machine.
5. Restart engine.



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INTENDED USE

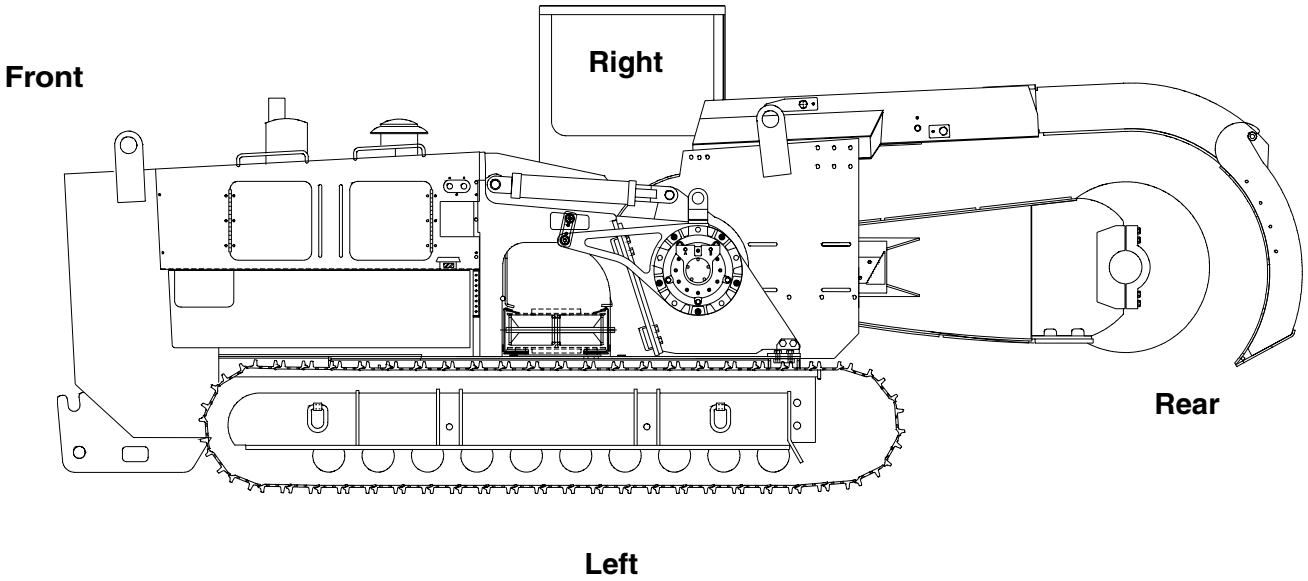
The Vermeer T655III Trencher is designed to efficiently dig trenches in a variety of widths and depths in various landscape/terrains and soil conditions. Trenching is controlled either by manual means or automatically depending on position of controls.

Spoil generated by trenching is deposited onto a conveyor belt and dispersed along side of trench. The adjustable conveyor allows the spoil to be deposited on either side of machine.

T655III SPECIFICATIONS

Machine Reference and Orientation

Left, right, front, and rear of the machine is determined by direction of travel when cutting. The engine is at the front of the machine; the attachment is at the back.



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Power Distribution Subsystem

12-volt system

150-amp current Max.

Batteries Two BCI Group Size: 31

Cold Cranking Amps: 955 each

Alternator 130-amp

Engine Subsystem

Model: John Deere 6090 HF485 9.0 L Power Tech

Aspiration: Turbocharged and air to air charge-cooled

Maximum Power: 250 hp (186 kW) measured at 2200 rpm

Normal oil pressure is 35–70 psi (240–480 kPa) at 2100 rpm. Engine will shut down if oil pressure drops below 10 psi (69 kPa).

Normal operating temperature is 160–205°F (71–96°C).

Air Cleaner: Dry-type with primary and secondary elements and restriction indicator

Implement Subsystem

Electrical Control Valve Solenoid Coil Resistance: All Sections: (8.3 ± 1 Ω)

Hydraulic System Type: Pressure/Flow-Compensated

System Pressure:

- High Pressure Compensator - 2500 psi (172 bar)
- Low Pressure Compensator - 400 psi (28 bar)

Continued on next page...

Control Valve Work Section Port Relief Pressures:

- Left Track Tilt Cylinder Extend: - 1200 psi (83 bar)
- Left Track Tilt Cylinder Retract - 1500 psi (103 bar)
- Right Track Tilt Cylinder Extend: - 1200 psi (83 bar)
- Right Track Tilt Cylinder Retract - 1500 psi (103 bar)
- Trench Cleaner Fold Cylinder Extend - 3000 psi (207 bar)
- Optional Conveyor Shift Motor FORWARD - 1200 psi (83 bar)
- Optional Conveyor Shift Motor REVERSE - 1200 psi (83 bar)

Ground Drive Subsystem

Electrical Microprocessor Controlled: (See page **2-16** for operating parameters).

Hydraulic System Type: Hydrostatic Closed-Loop

System Pressure: 5000 psi (345 bar)

Charge Pressure: 350 psi (24 bar)

Attachment Subsystem

Electrical Microprocessor Controlled: (See page **2-16** for operating parameters).

Hydraulic System Type: Hydrostatic Closed-Loop

System Pressure: 5000 psi (345 bar) Max.

Charge Pressure: 450 psi (31 bar) Max.

Shuttle Relief Pressure: 350 psi (24 bar) Max.

Thermal Bypass Valve Shift Temperature Range 130–150°F (54–65°C)

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Cross Conveyor Subsystem

Hydraulic

System Type: Open Loop

System Pressure: 2500 psi (172 bar) Max.

Auxiliary Subsystem

Electrical

Control Valve Solenoid Coil Resistance: All Sections: (8 ± .8 Ω)

Hydraulic

Refer to Implement subsystem for information on hydraulic specifications.

Load/Return Conveyor Subsystem

Hydraulic

System Type: Open Loop

System Pressure: 2500 psi (172 bar) Max.

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Fluid and Lubricants

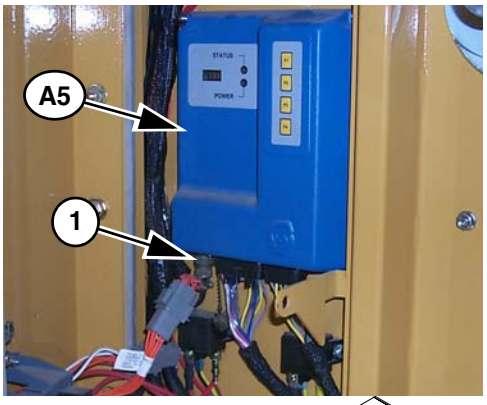
Fluid/Lubricant / *Recommendation*	Capacity	**Specification** / Notes
Fuel	85 gal (320 L)	An Engine Operation Manual is supplied with each machine. Refer to the manual for engine service requirements.
Engine Oil (with Filter)	33.2 qt (31.42 L)	
Coolant	42.2 qt (39.94 L)	Use a 50/50 mixture of low-silicate ethylene glycol antifreeze and clean water. Never add pure antifreeze to a cooling system. Never use high-silicate antifreeze or antifreeze that is higher than 60/40 mixture. Refer to engine manual.
Hydraulic Fluid *Vermeer HyPower Hydraulic Fluid*	85 gal (320 L)	**ISO 68 Oil** -20°C to 40°C (-4°F to 104°F) **ISO 100 Oil** -10°C to 50°C (+14°F to 122°F) **NOTE:** ISO 68 oils are recommended and should be used for most applications. **NOTE:** Use of any other hydraulic oil without written factory approval will jeopardize warranty. **NOTE:** Do not spill dirt or other contaminants into tank. Filter all fluid through a 10-micron filter before adding.
Pump Drive Gearbox Fluid	7-3/4 qt (7.3 L)	**SAE 80W-90 all-purpose gear lube** -20°C to 40°C (-4°F to 104°F) **SAE 85W-140 all-purpose gear lube** -10°C to 50°C (+14°F to 122°F) Gear oil must meet API GL-5 or MIL-L-2105D
Track Drive Gearbox Fluid	1.3 gal (5 L)	
End Idler Fluid	As required	
Conveyor Shift Gearbox Fluid	As required	
Grease *Vermeer Ultra LF Grease*	As required	EP grease - Vermeer Ultra LF or equivalent

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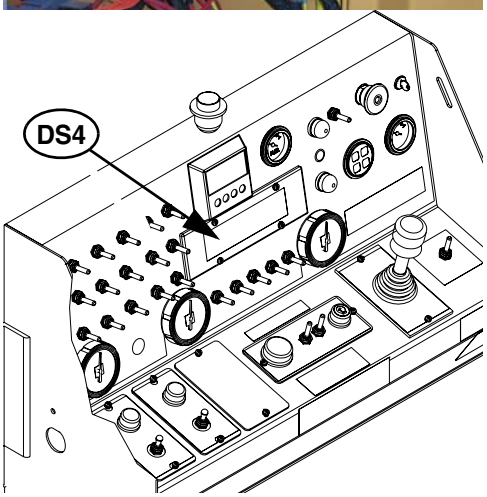
TRENCHER ELECTRONIC CONTROL

TEC 2000 Microprocessor A5 & Display DS4

The TEC 2000 control system consists of a microprocessor A5 and display screen DS4 that work in conjunction with one another to control machine functions and display operating parameters. The microprocessor and display are discussed here because they are common to, and control circuits in more than one subsystem.



The microprocessor and the functions related to the specific subsystems are discussed in the individual theory chapters as well. The microprocessor is illustrated in MAPs shown in theory chapters of the various subsystems.



The microprocessor receives power from a 10-amp fuse and ground from the machine chassis. The display screen DS4 is connected to the microprocessor through cable **(1)**.

Continued on next page...

The microprocessor is the local intelligence that acquires input signals from the various sensors, controls and interlocks. Input signals are processed by the controller. Output signals are sent to the appropriate control circuits, allowing actuator function.

The microprocessor automatically monitors and detects data transmission errors and diagnostic faults and displays them on the display screen.

The following pages consists of:

- Microprocessor Identification - page **2-10**
- Microprocessor Pin Designations and Functions - page **2-11**
- Machine Interlock Functions - page **2-13**
- Default Screens - page **2-15**
- View Screens - page **2-16**
- Setup Screens - page **2-17**
- Modify Screens - page **2-19**
- Fault Screens - page **2-20**
- Microprocessor Troubleshooting - page **2-22**
- Microprocessor Calibration - page **2-20**

NOTE: Calibrating the microprocessor is necessary after replacing a pump, EDC, or PPU.

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Microprocessor Identification

Keys F1–F4 are used for navigating through the system's functions.

F1 - to enter calibration mode

F2 - to change screen menus

F3 - to increase values

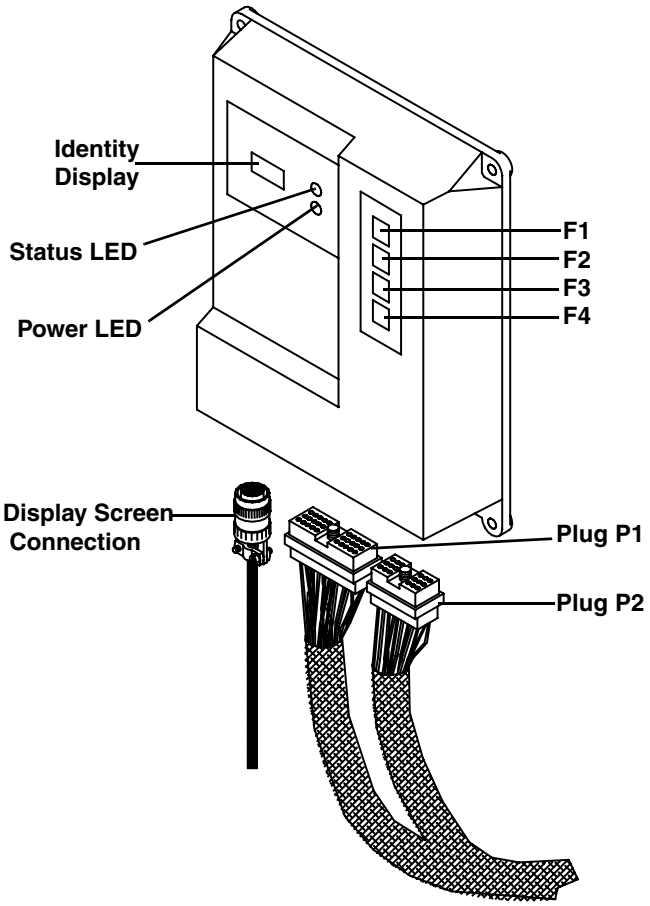
F4 - to decrease values or toggle settings ON/OFF

Identity Display - identifies travel mode **AUTO / MAN**

Status LED - A red LED illuminates indicating faults have occurred.

Power LED - A green LED illuminates indicating there is power at the microprocessor.

Display Screen Connection - connects the display screen to the microprocessor



Plug P1 - control harness connection

Plug P2 - control harness connection

Pin Designations and Functions

Plug P1

A1 - Sensor Power (output)

A2 - Steering Potentiometer Signal (input)

B2 - Engine PPU (input)

C2 - Load Control Potentiometer (input)

D2 - Propel Lever Signal (input)

E2 - Seat Switch

F2 - Attachment Speed Potentiometer Signal (input)

G2 - Attachment Switch

J1- Left Track EDC (A Coil)

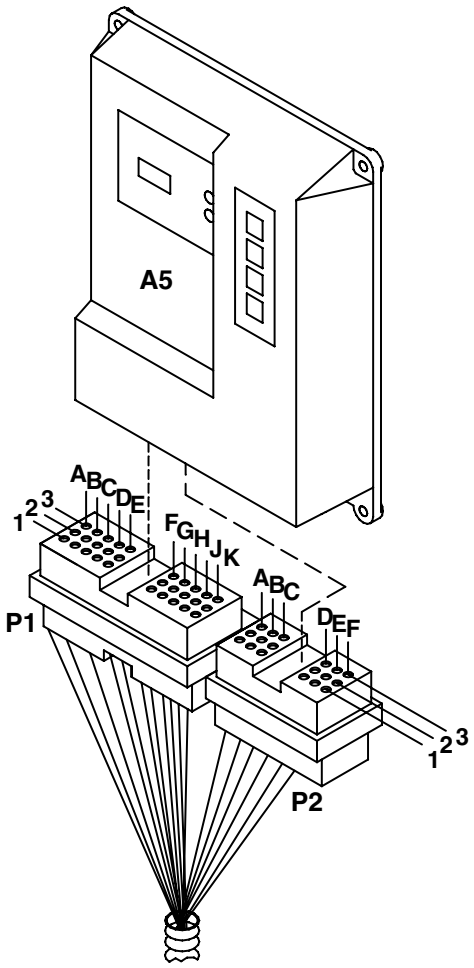
J2 - Left Track PPU

J3 - Left Track EDC (B Coil)

K1 - Right Track EDC (A Coil)

K2 - Right Track PPU

K3 - Right Track EDC (B Coil)



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Plug P2

A1 - Travel Mode Switch

B2 - Chassis Ground

C1 - HI/LOW Range Switch

C2 - Propel Neutral Switch

D2 - Start Relay +

D3 - Park Brake Switch

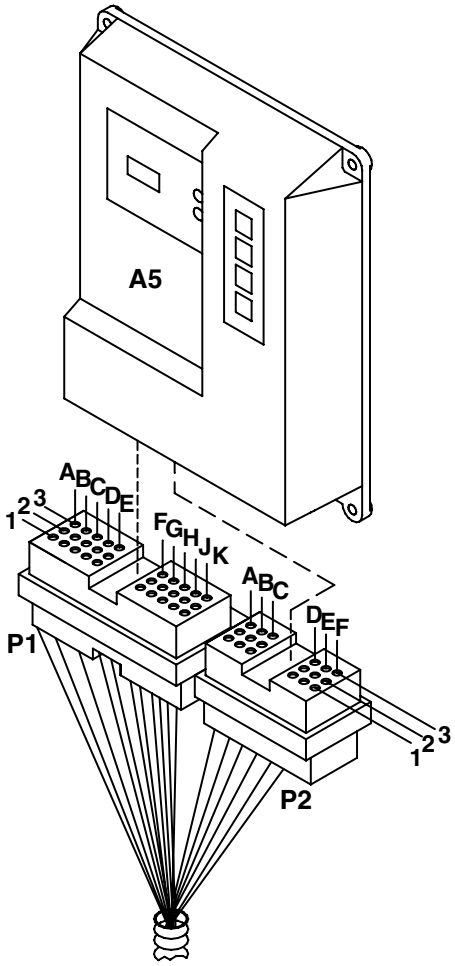
E1 - Battery - (input)

E2 - Next Display Switch (input)

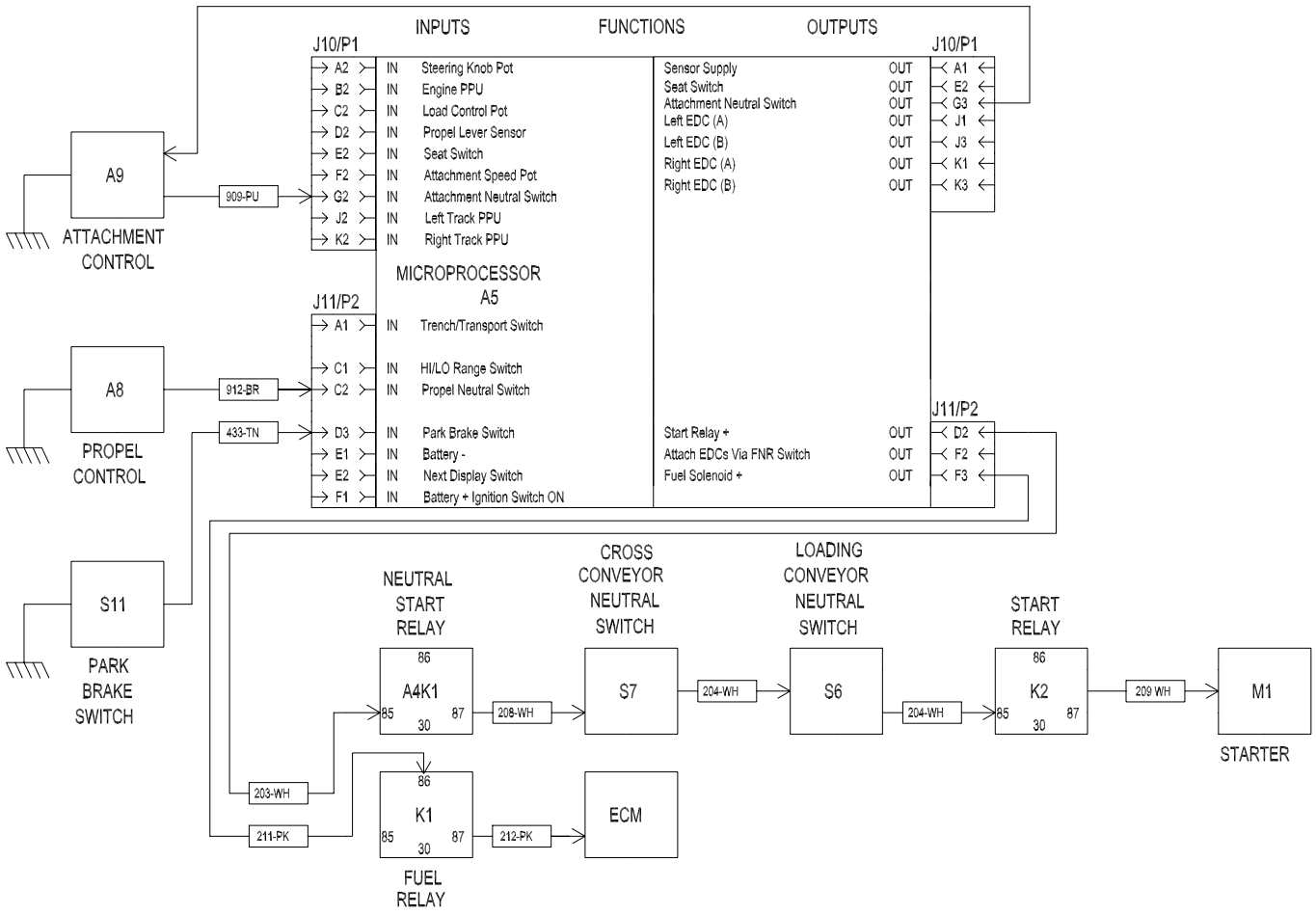
F1 - Battery + Ignition Switch ON (input)

F2 - Attachment EDCs Via FNR Switch (output)

F3 - Fuel Solenoid (output)



Machine Interlock Functions



Engine Start Interlocks

The interlocks are discussed here as well as in the Theory Chapters of subsystems where they apply. Several control components wired to the microprocessor A5 must be in their NEUTRAL positions before the engine can start. When these interlocks are not in their NEUTRAL positions, they are grounded. Whenever the microprocessor receives a ground signal from an interlock switch, it will not supply voltage to the start relay K2.

The following controls must be set as follows:

- Park Brake Switch - ON
- Attachment Control - NEUTRAL
- Propel Control - NEUTRAL
- Cross and Loading Conveyor Controls - NEUTRAL

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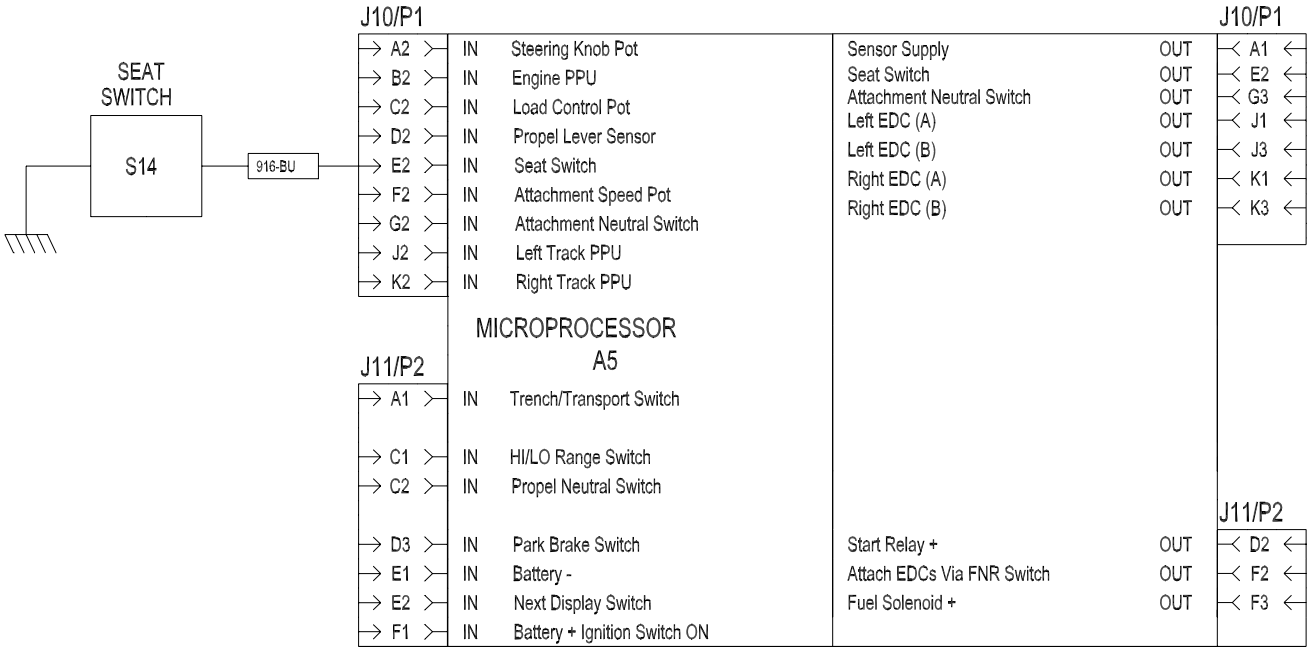
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The microprocessor has two voltage outputs for engine START and RUN functions. One output supplies voltage to energize the neutral start relay A4K1. The neutral start relay switches power to the start relay K2. The start relay supplies power to energize the solenoid of starter motor M1.

The conveyor switches located on the control valve assemblies are wired in series with the neutral start and start relays. When in NEUTRAL, the switches are closed, completing the circuit to the start relay. If the switches are not in NEUTRAL position, supply voltage to the start relay will be lost.

The other output supplies voltage to energize the fuel relay K1. The fuel relay switches power to the engine ECU (electronic control unit). The ECU energizes the fuel injector's electronic control and regulates the fuel injection pressure, timing, and duration.

Operator Presence Interlock



The operator presence interlock uses a normally open switch S14 in the seat to detect the presence of the operator. The operator must be seated before the ground drive or attachment drives can be engaged. If the operator leaves the seat while these systems are operating, they will stop within approximately 3–4 seconds. Controls must then be returned to NEUTRAL before they can be restarted.

When the seat is occupied, the switch closes and supplies a ground signal to the microprocessor A5. With the seat switch closed, the ground drive and attachment subsystems will operate.

Default Screens

When turnig ignition key to the ON position (engine not running) and all controls are in NEUTRAL, the operator screen DS4 default will show engine RPM, travel mode, and degree of turn.

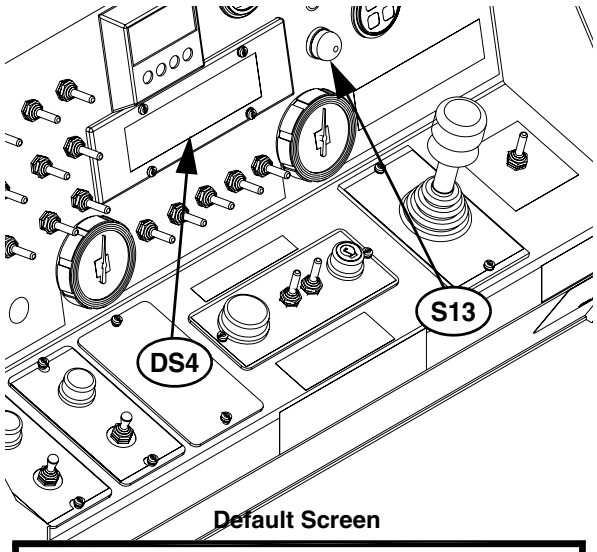
When turning ignition key to the ON position and machine interlocks are not in NEUTRAL, the operator screens will disappear. Interlocks included are:

- attachment
- propel
- park brake

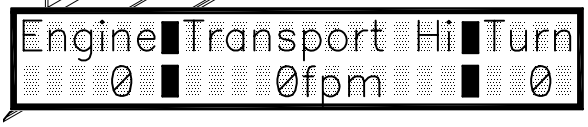
Place interlocks in NEUTRAL, press toggle button **(S13)**, the default screen will appear again.

NOTE: The engine will not start if interlocks are not in NEUTRAL.

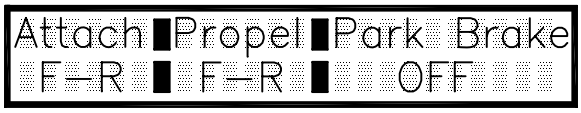
Refer to page **2-13** for more information on interlocks.



Default Screen



Interlock Screen



2nd Screen



The operator can view the various screen displays by pressing the toggle button S13. Pressing the button once from the first default screen will display battery voltage, engine hours, and attachment speed. Attachment speed is displayed as a percentage.

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View Screens

View screens display information received from inputs and outputs of the various control components to the microprocessor. To access view screens, press F2 key on microprocessor. Use toggle button S13 to navigate through view screens. Ensure VIEW: is in the left corner of display screen.

Steering Knob

Displays voltage received from steering potentiometer to microprocessor. Normal range is (0.5–4.5V).



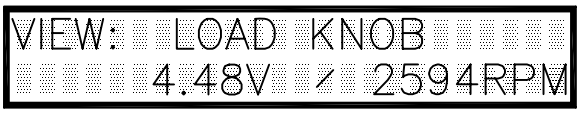
Propel Lever

Displays voltage received from the propel potentiometer and the percentage of travel on the FORWARD or REVERSE. Normal range is (1.5–3.5V).



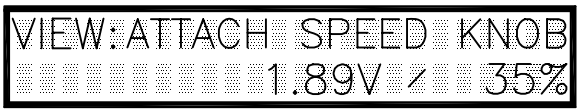
Load Control Knob

Displays voltage received from the load control potentiometer, along with engine RPM, at which load control feature will begin to work. Normal range is (0.5–4.5V).



Attachment Speed Knob

Displays voltage received from the attachment speed control potentiometer, along with speed percentage. Normal range is (0.5–4.5V).



Track Pumps EDC Command

Displays a milliamp reading of what the microprocessor is sending to the track pumps EDCs. Normal range is (-95–+95 mA).



Track Pumps EDC Volts

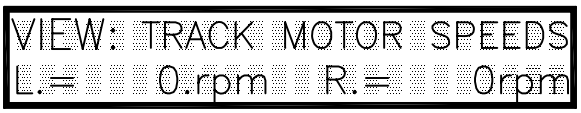
Displays a voltage reading of what the microprocessor is sending to each of the track pump EDCs. Normal range is (-4–+4.0V).



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Track Motor Speed

Displays the PPU signal received by the microprocessor from each track motor as an RPM reading. Normal range is (-4000–+4000 rpm).



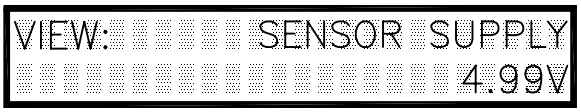
Hydraulic Oil and Engine Coolant Temperatures

Displays the hydraulic oil and engine coolant temperatures.



Sensor Supply

Displays the regulated supply voltage that is being sent out to the machine sensors. Normal range is (4.75–5.25V).



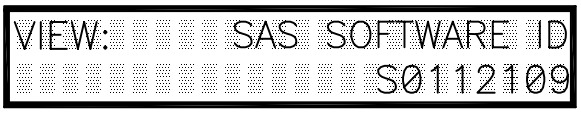
Machine Model

Displays the machine model the microprocessor is calibrated to.



Software ID

Displays the ID number of the software running the control system.



Setup Screens

Setup screens allow the technician to change certain machine parameters and display options. To access, press F2 key twice. Use the toggle button to navigate through setup screens. Ensure SETUP is in the left corner of display screen.

Maximum Propel in Trench Mode

Increases maximum track speed in trench mode. Normal range is (0–100% in 10% increments).



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Maximum Load Control Adjustment

Increases default settings on engine RPM. Normal range is (-150–+400 rpm).



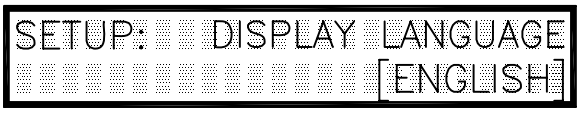
Attachment ESL (Electronic Stroke Limiter)

Turns the attachment ESL ON or OFF.



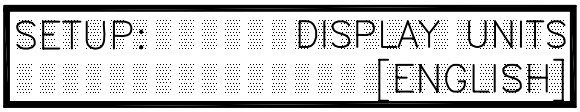
Language Adjustment

Allows choice of different languages offered.



Display Units

Allows unit of measure to be changed to english or metric.



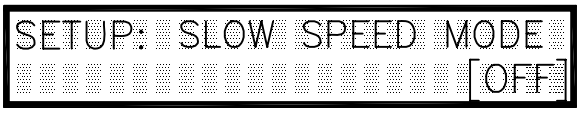
Fault Mode

Report faults. No changes can be made.



Slow Speed Mode

Allows slow speed mode to be turned ON or OFF.



View Angle

Adjusts display view angle for best visability.



Modify Screens

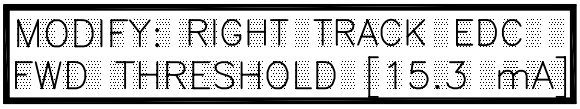
The modify screens display the track drive motor EDC threshold values. Values are determined by input/output data received from the microprocessor during calibration procedures. To gain access to this screen, press F2 key twice (Setup Screen). Press and hold F1 and press F3. To exit these screens, press F2.

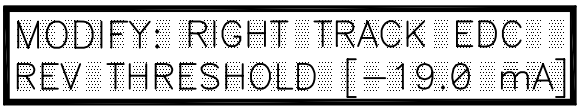
These values should not be altered or changed, unless using Trench Low (Slow Speed Mode). See below.

Examples









Trench Low (Slow Speed Mode)

During extremely hard digging conditions the track motor speed reading can be inaccurate, causing surging, and/or uneven track control. Trench Low takes the PPUs out of the system and allows the machine to run from approximately 0 to 5 fpm (feet per minute) or 0–1.5 m/min..

Slow Speed Mode can be turned ON or OFF by use of setup screen. Press F2 twice for setup screen and F4 for ON or OFF options. The engine load knob is used as a propel knob when in Trench Low. The steering stays the same.

When in Trench Low, steering corrections may need to be made to achieve equal track pressures. Ground drive thresholds may need to modified slightly to achieve equal track pressures at zero steer. Calibrating will ensure the left and right track pumps come on stroke equally at zero steer. Refer to the Trench Low calibration procedures on page 2-27.

NOTE: When switching back into regular mode from Trench Low, the thresholds do not need to be set, and machine does not need to be recalibrated.

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Fault Screens

Instead of using the common numeric codes, the TEC software uses an abbreviated code. Technicians should have a good idea of what the faults are by looking at the fault log and the active faults that flash on the display.

Fault Log

The TEC records fault codes as it detects a system fault. The number to the right of the fault code represents the number of times that specific fault has occurred.



The initial fault screen will always appear first. The number in parentheses represents the status of the microprocessor. A zero or two is acceptable. If any other number appears, contact the Track Service Department to verify. It may be internally defective.

Navigation

The fault log can be displayed by pressing the F2 key on the microprocessor three times. Use the toggle button to the right of the display screen to navigate through recorded fault code screens.

Clearing A Fault

After a fault has been corrected, go to the fault log display screen. To achieve this, press the F2 key three times. Find the corrected fault code and press the F4 key. This will clear the fault from the fault log.

Fault Table

TEC 2000 FAULTS	DESCRIPTION
SERVICE CONTROLLER	Several different conditions can cause this fault. It is used to indicate a failure in the controller software or hardware. The number displayed and recorded in the Controller fault log gives further information about the last fault. These numbers are useful in diagnosing the problem with the controller.
SENSOR POWER	Measured sensor power voltage is not within 4.75V to 5.25V.
PROPEL POT	Propel Lever Pot reading is more than 0.1V outside the calibrated range (full reverse to full forward).
NEUTRAL SWITCH OUT OF RANGE	Propel Lever Sensor voltage reading is outside of calibrated ″NEUTRAL Deadband″ when FNR is in neutral (based on neutral switch) or propel lever sensor voltage is outside of calibrated NEUTRAL band when FNR is not in NEUTRAL.
STEERING POT	Steer Pot reading is more than 0.1V outside the calibrated range (left stop to right stop).
ATTACH SPEED POT	Attachment Speed Pot reading is more than 0.1V outside the calibrated range (left stop to right stop).
ENGINE LOAD POT	Trencher Speed Pot reading is more 0.1V outside the calibrated range (left stop to right stop).
ENGINE PPU LOST SIGNAL	Measured Engine RPM is 0 rpm but either left or right measured motor speed and the corresponding valve current are non-zero.
LEFT EDC SHORT CIRCUIT	Left EDC Coil Resistance is less than 5 Ω The check is only done when there is current commanded.
LEFT EDC OPEN CIRCUIT	Left EDC Coil Resistance is greater than 40 Ω The check is only done when there is current commanded.
RIGHT EDC SHORT CIRCUIT	Right EDC Coil Resistance is less than 5 Ω The check is only done when there is current commanded.
RIGHT EDC OPEN CIRCUIT	Right EDC Coil Resistance is greater than 40 Ω The check is only done when there is current commanded.
BATTERY POWER	Measured Battery Voltage is not within 9V to 16V on 12V systems or 18V to 32V on 24V systems and engine RPM is at least 500 rpm.

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Microprocessor Troubleshooting

Look for the obvious, broken wiring and corrosion. The microprocessors use low voltage and amperage signals. Moisture getting into the wiring will cause corrosion, and this leads to sensor errors.

The microprocessor rarely fails. A few conditions which may cause failure of the microprocessor include:

- grounding accessories through the controller
- welding on machine

Welding Precautions

To avoid microprocessor failure, turn the ground disconnect to the OFF position before any type of welding occurs on the machine.

NOTE: The microprocessor troubleshooting is based on the fault codes displayed on the display screen and only covers basic electrical faults. Refer to the individual subsystem Troubleshooting Chapters for detailed circuit troubleshooting procedures including electrical and hydraulic.

Troubleshooting Table

TEC 2000 FAULTS	TROBLESHOOTING CHECKS
SENSOR POWER	Usually caused by a potentiometer being shorted to ground. • Check battery voltage. • Check wiring harness. • Check connections coming from the battery voltage to the microprocessor for shorts or opens. • Check voltage supply line coming into the microprocessor.
PROPEL POT	• Display propel lever view screen and look for a voltage change while moving the lever. This will ensure voltage signal to microprocessor (normal range 1.5–3.5V). • Check connection between propel lever and microprocessor. • Remove propel lever, look for faulty wiring, broken or loose parts or a faulty potentiometer.
NEUTRAL SWITCH	• Display propel lever view screen and look for a voltage change while moving the lever. This will ensure voltage signal to microprocessor (normal range 1.5–3.5V). • Recalibrate propel lever. • Check connections between propel lever and microprocessor. • Remove propel lever, look for faulty wiring, switch, or a faulty potentiometer.
STEERING POT	• Display steering view screen and look for a voltage change while turning the steering knob. This will ensure voltage signal to microprocessor (normal range 0.5–4.5V. • Check connection between steering control box and microprocessor. • Check steering control and look for faulty wiring or potentiometer.
ATTACHMENT SPEED POT	• Display attachment speed knob view screen and look for voltage change while moving the attachment speed knob. This will ensure voltage signal to microprocessor (normal range 0.5–4.5V). • Recalibrate attachment speed knob. • Check connection between attachment control and the microprocessor. • Check attachment control and look for faulty wiring or potentiometer.

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TEC 2000 FAULTS	TROBLESHOOTING CHECKS
ENGINE LOAD KNOB	• Display the engine load knob view screen and look for voltage change while moving the engine load knob. This will ensure voltage signal to microprocessor (normal range 0.5–4.5V). • Recalibrate the engine load knob. • Check connection between engine load knob and microprocessor. • Check engine load knob control and look for faulty wiring or potentiometer.
ENGINE PPU	• Check engine PPU and connector. • Check PPU gap to engine flywheel is 1/2 turn. • Check wiring from PPU to microprocessor.
LEFT OR RIGHT TRACK PPU	This will not appear on screen (retrieved from fault log). • Check PPU gap (refer to PPU install chart). • Check wiring from PPU to microprocessor.
LEFT OR RIGHT EDC SHORT	• Check for short between EDC and microprocessor. • Check for short in EDC.
LEFT OR RIGHT EDC OPEN	• Check for broken wire or loose connection (open) between the EDC and the microprocessor.
BATTERY POWER	• Check alternator output voltage. • Check connection between battery and alternator. • Check connection between battery and microprocessor. • Check connections between microprocessors and ground.

Calibration

After replacing any sensor, pump, EDC, or PPU, the following steps will need to be performed to correctly calibrate the microprocessor.

WARNING: Machine or attachments could move unexpectedly during calibration. Keep everyone away from machine. Allow enough clearance around machine if movement should occur. Death or serious injury can result if run over or crushed.

NOTE: Tank temperatures must be between 60–90°F. clean all mud, rocks, and debris from the tracks. Machine must be on a level and smooth surface.

1. Set engine throttle to low idle.
2. Center steering knob to the straight tracking position.
3. Move track speed range switch to LOW.
4. Move travel mode switch to MANUAL.
5. Turn all other knobs to the LOW setting.

NOTE: Ignition key must be OFF before pressing F1.

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6. Open electrical assembly door.
7. Press and hold F1 button on front of microprocessor until Step 10.
8. Turn key to ON.

Confirm machine model on display screen. The display will read **CALIBRATE MODE RELEASE SWITCH TO BEGIN**. Do not release switch at this time! If incorrect model, press F4 while continuing to hold F1 until the proper model appears.

9. Start engine and let it stabilize at low idle RPM.
10. Release F1 button.
11. Turn steering knob to both stops. This causes the message **STEER KNOB: TURN TO CW AND CCW STOPS** to drop out.
12. Turn RPM knob to both stops. This causes the message **ENGINE LOAD KNOB: TURN TO CW AND CCW STOPS** to drop out.
13. Turn park brake OFF.
14. Increase engine speed to full throttle.

WARNING: The machine could move on steps 15 and 18 if PPU is faulty.

15. Move propel lever slowly out of NEUTRAL and in the FORWARD direction until the display reads **PROPEL LEVER: MOVE TO MAX FORWARD AND WAIT**. When this appears, push lever to full FORWARD position. **MOVE LEVER TO NEUTRAL** will appear**.**
16. Repeat previous step but move lever in REVERSE direction when **MOVE LEVER TO NEUTRAL** display appears in the REVERSE direction.
17. Turn attachment knob to both stops. This causes the message **ATTACH KNOB: TURN TO CW AND CCW STOPS** to drop out.
18. Move attachment FORWARD/REVERSE switch to forward and wait. Wait for the message **RETURN ATTACH SWITCH TO NEUTRAL** to appear. Once the message appears, return switch to NEUTRAL and repeat process for REVERSE. This causes the message **ATTACH FNR SWITCH: MOVE TO FWD OR REV.** to drop out.
19. The display should now read: **PRESS CALIBRATE (F1) SWITCH TO CONTINUE**.
20. Press F1. The display should read: **CALIBRATION WAS SUCCESSFUL** and then **RESTART MACHINE TO OPERATE**.

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IMPORTANT: Do not turn key to OFF until RESTART MACHINE TO OPERATE appears on screen. Failure to do so will void calibration.

21. Decrease engine speed to idle, turn ON park brake and turn key to OFF.

22. Close electrical assembly door.

Machine is ready for operation.

NOTE: To calibrate only single components, use F1 to exit calibration mode after calibrating that component.

Calibrating Single Components

If a single component has been replaced, only that specific component will need to be calibrated. Follow the Machine Calibration Steps 1–10 then use procedures pertaining to the replaced component. For example, if the component replaced was part of the ground drive propel, skip procedures for attachment function. Other components will default back to previous settings.

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Chapter 3—Power Distribution Subsystem

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Chapter 3: Power Distribution Subsystem

Section A: Theory

OVERVIEW

The Power Distribution subsystem consists of electrical circuits and components common to all other machine subsystems. These components are involved in the development and distribution of operating current required by the machine's electrical systems.

Circuits/Components

The following circuits and components are used in the Power Distribution Subsystem:

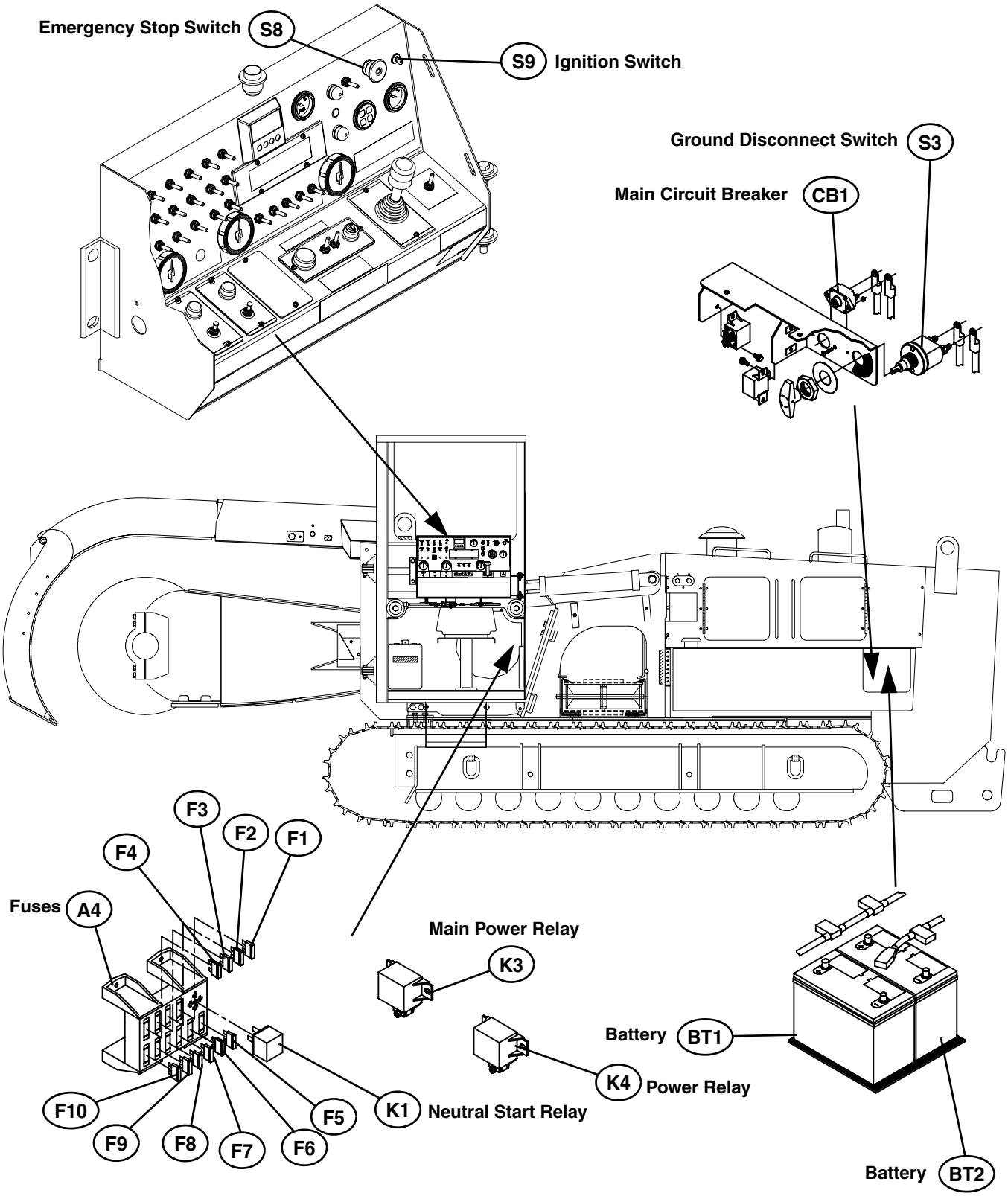
Ignition ON Circuit:

Ground Disconnect Switch S3
Batteries BT1 & BT2
150-Amp Circuit Breaker CB1
Main Power Relay K3
Power Relay K4
Fuses A4F1 - A4F10
Ignition Switch S9
Emergency Stop Switch S8
Alternator G1

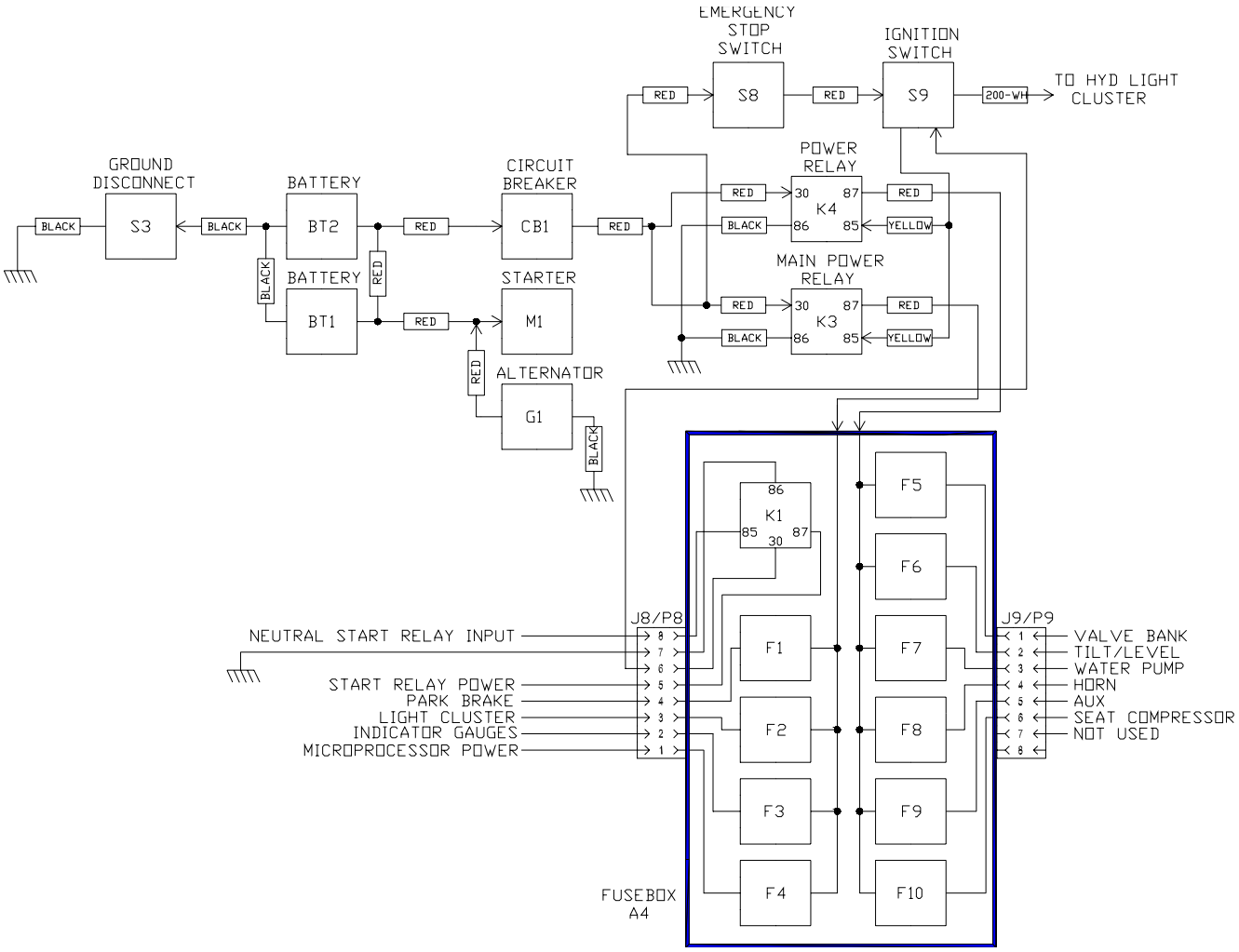
NOTE: The alternator G1 is considered to be a component of the Power Distribution subsystem. The alternator does not function until the engine has been started, therefore the theory of operation of the alternator and charge circuit is discussed in the Engine subsystem Chapter 5A.

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Component Locations



IGNITION ON CIRCUIT



Operation

NOTE: Refer to the Engine subsystem Theory Chapter 5A for information on ignition switch START/RUN and CHARGE circuits.

The following theory of operation explains how the ignition ON circuit works using the components shown in the above MAP. Following the theory of operation is a detailed description of the individual components.

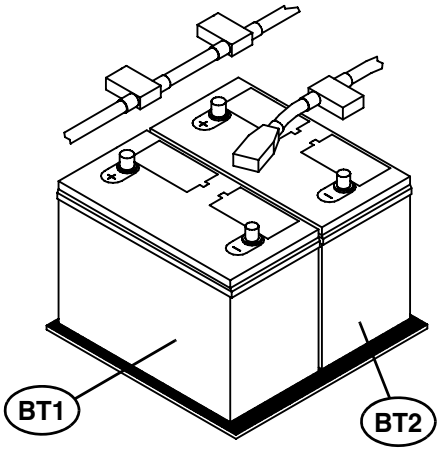
When ignition switch S9 is turned to the ON position, emergency stop switch S8 is connected or pulled out, and ground disconnect switch S3 is in the connected position, source voltage from batteries BT1 & BT2 is available to energize the two power relays K3 & K4. Relay K3 provides voltage to the left side fuses F1–F4 of fuse block A4. Relay K4 provides voltage to the right side fuses F5–F10 of fuse block A4.

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Batteries BT1 & BT2

Two 12-volt, negative-ground, BCI Group 31 batteries BT1 & BT2 are connected in parallel with one another to provide 12-volt power for machine electrical functions.

When in good condition, the batteries produce approximately 955 cold cranking amps each.

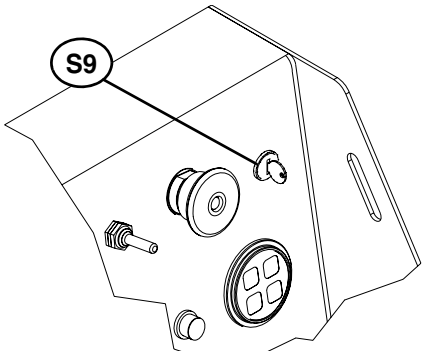


Ignition Switch S9

The ignition switch is a 4-position switch. The switch gets voltage from batteries through the 150-amp circuit breaker and emergency stop switch, and ground from machine chassis.

The four switch positions are:

LEFT (counterclockwise) - power to accessories



OFF (vertical) - shuts off engine and electrical system

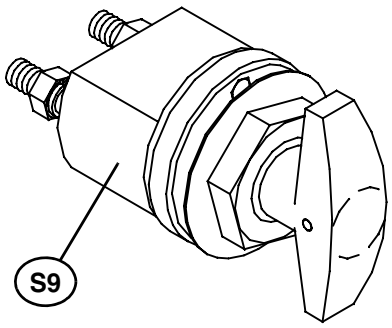
ON (clockwise 1 stop) - turns electrical system ON

START (fully clockwise) - starts engine

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Ground Disconnect Switch S3

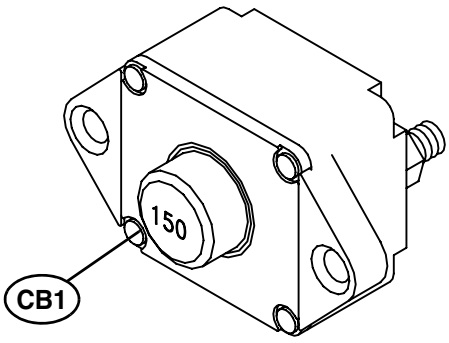
The ground disconnect switch S3 is a 2-position switch with chassis and engine grounds connected to one terminal, the battery's negative post connected to the other terminal. This switch provides the primary ground for all the machine's electrical functions. The switch provides a fail-safe guard against accidental starting and operation.



Circuit Breaker CB1

The 150-amp circuit breaker CB1 is in line between the batteries and ignition switch and protects the electrical system from damaging high current conditions.

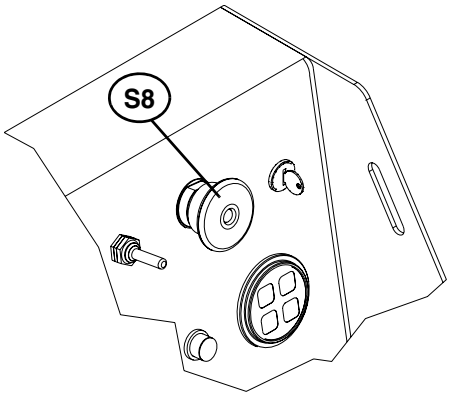
During operation, if a short or overload situation occurs, the normally closed breaker trips and battery voltage will be lost. The breaker will have to be reset by pushing the button.



Emergency Stop Switch S8

The switch gets voltage from batteries through the 150-amp circuit breaker and emergency stop switch, and ground from the machine chassis. If an emergency situation occurs during operation, the operator can push the switch.

The normally closed switch will open, cutting the voltage to the ignition switch BAT terminal. The engine will shut down and all electrical functions will be lost. Pulling the switch out will restore voltage and allow the engine to be restarted.

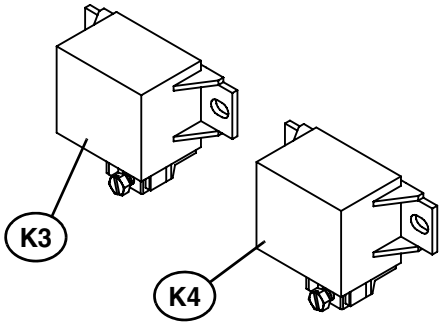


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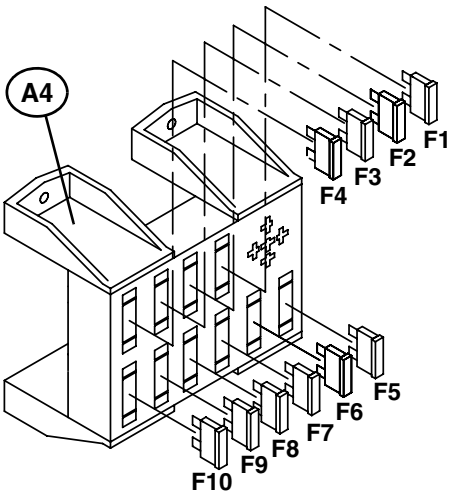
Power Relays K3 & K4

The relays get voltage from the batteries through the 150-amp circuit breaker and ground from machine chassis. The power relays when energized, provide a voltage path to the fuse box and all electrical circuits.



Fuse Box A4

The fuses get voltage from the power relays when energized. The fuses protect the individual electrical circuits from overload and provide voltage to the following components:



Fuse F1 is a 5-amp fuse and provides voltage to:

- Park Brake Switch S11
- Ether Soleniod L4
- Attachment FNR Switch A9
- Speed Range Switch A7
- Engine ECM
- Park Brake Switch S11

Fuse F2 is a 5-amp fuse and provides voltage to:

- Attachment Case temperature Switch TS1
- Hydraulic Tank Level Switch S2
- Hydraulic Return Filter Pressure Switch S1
- Hydraulic Light Cluster DS5
- Charge Filter Switches

Fuse F3 is a 5-amp fuse and provides voltage to:

- Fuel Gauge DS2
- Hydraulic Tank Oil Temperature Gauge DS3

Continued on next page...

Fuse F4 is a 5-amp fuse and provides voltage to:

- Microprocessor TEC2000 A5

Fuse F5 is a 5-amp fuse and provides voltage to:

- Trencher Auto Down Pressure Switch S27
- Conveyor Fold Switch S26
- Dirt Drags Switch S25
- Crumber Fold Switch S24
- Conveyor Shift Switch S23
- Trench Cleaner Shoe Switch S22
- Trencher Boom Lift Switch S21
- Coulter Wheel Switch S20
- Jib Raise Switch S19
- Jib Extend Switch S18

Fuse F6 is a 5-amp fuse and provides voltage to:

- Auto Leveling Switch S28
- Left Machine Level Switch S31
- Right Machine Level Switch S32
- Left Tilt Track Switch S29
- Right Tilt Track Switch S30

Fuse F7 is a 5-amp fuse and provides voltage to:

- Water Pump

Fuse F8 is a 10-amp fuse and provides voltage to:

- Horn Switch S34

Fuse F9 is a 5-amp fuse and is not used.

Fuse F10 is a 15-amp fuse and is not used.

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Chapter 3: Power Distribution Subsystem

Section B: Troubleshooting

OVERVIEW

Pretest Inspection

Before testing circuits, always visually check for broken, missing, corroded, or loose wires and cable connections on the power wires that supply electrical circuit components. Check all ground connections on the machine and chassis for tight connections. Fix or replace any other problems found.

Test Equipment Needed

Digital Multimeter

IGNITION ON CIRCUIT

Electrical Troubleshooting

When the ignition switch is turned ON, power should be available to all machine electrical functions. Refer to the Power Distribution Theory in Chapter 3A for detailed information on the theory of operation.

NOTE: The alternator G1 is considered a component of the Power Distribution subsystem. The alternator does not function until the engine has been started, therefore the troubleshooting of the alternator and charge circuit is discussed in the Engine subsystem Chapter 5B.

The fuse box fuses F1–F10 are also considered components of the Power Distribution subsystem. However the individual fuses are responsible for protecting electrical circuits in several subsystems. Therefore they are also discussed in their appropriate subsystem troubleshooting chapters.

NOTE: Before beginning any troubleshooting, perform the pretest inspection. Also review information in the General Information chapter under “Troubleshooting Guidelines,” page **1-9**.

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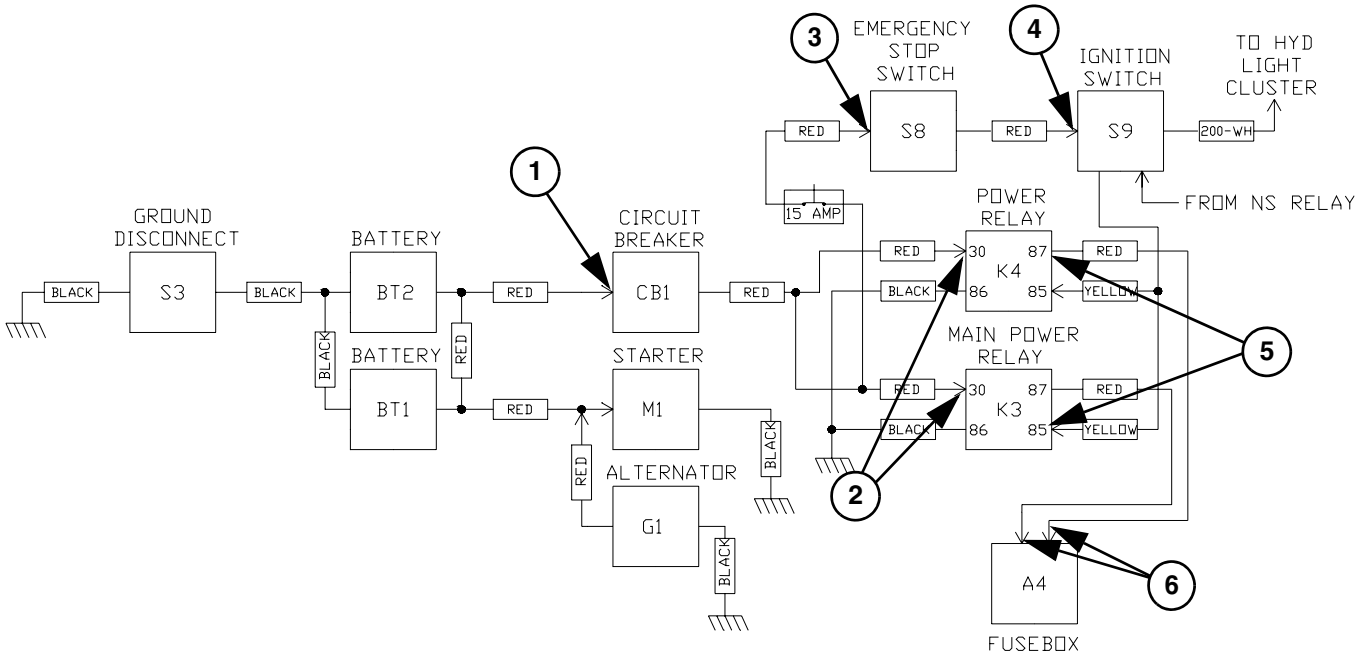
Testing Sequence

The testing sequence gives a troubleshooter a logical place to begin troubleshooting the circuit. The sequence is based on certain conditions. In this case, whether or not the main circuit breaker has tripped. The circuit breaker is rated at 150 amps. This is the maximum amount of current draw the breaker will allow before it trips.

If there is no power to the ignition ON circuit and the main circuit breaker CB1 has not tripped, test power source (battery voltage) first. If batteries are OK, test for an open circuit. If there is power but lights are dim or functions are slower than normal, test for high resistance in the circuit.

If the breaker CB1 has tripped, it would indicate that resistance in the circuit is to low, allowing to much current through. This would be the result of a short in the circuit. Refer to page **3B-5** and test for a short circuit.

Power Source Distribution MAP

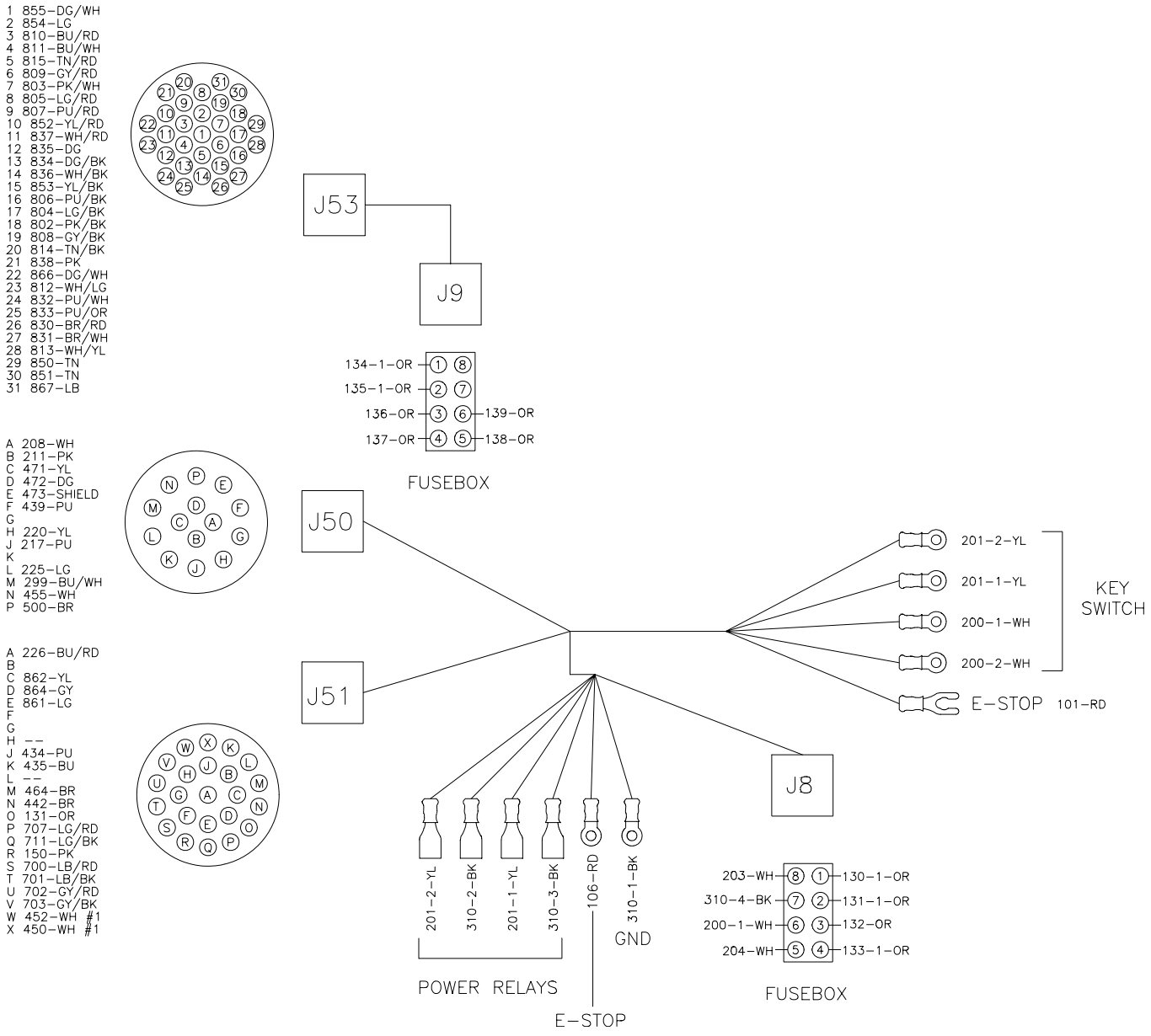


The MAP above shows the interdependencies of the power distribution components. The lines and arrows represent the inputs and outputs to and from each component.

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Component Pin/ Terminal Reference



The diagram above represents the wire harness connections of most of the power distribution components. Use the diagram for pin, terminal, wire, and plug reference when testing circuits and components. Only the wire harness connections relevant to the power distribution circuits are represented.

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Source Voltage Test

1. Test batteries BT1 & BT2 for acceptable voltage.

NOTE: The machine has a 12-volt system. Two batteries connected in parallel. The system voltage will be no greater than the voltage of the weakest battery.

2. Disconnect battery cables. With the multimeter set to measure DC voltage, connect probes to the positive and negative terminals of one of the batteries. Then test the other battery. The multimeter should read 12–13.5 volts.

NOTE: The batteries may test OK until they are loaded. To thoroughly test batteries, they should be tested under load.

3. Disable engine by disconnecting fuel solenoid to keep it from starting. With the multimeter set to measure DC voltage, connect the probes to the positive and negative terminals of the battery BT2 and crank the engine starter for 10–15 seconds.

   Expected result: A fully charged battery should measure above 9 volts. If so, the batteries are OK. Refer to the following and test for an open circuit. If not, replace bad battery(s).

Open Circuit Test

1. Ensure batteries are OK and fully charged. Set multimeter to measure DC volts and turn the ignition switch ON. Place meter's negative lead at negative post of battery BT2. Test for an open in the circuit by testing voltage at power input and output pins/terminals of plugs and components at test points 1–6. See MAP on page **3B-2**. Testing at these points, working through the circuit, will isolate the failed component(s) by process of elimination. Continue through the steps until the open is found.

   Expected result: When the positive lead is placed before an open point, the meter will read full battery voltage. When the lead is placed beyond the open, the meter will read no voltage, indicating that a complete circuit exists from the chassis ground to the point where voltage is last seen in the circuit.

2. Once the open is found, turn ignition switch OFF, unplug wire harness at the suspected component and test component for continuity. If the component is OK, test the wires connecting the component for continuity. Replace faulty component or section of wire harness. If battery voltage is measured at points 1-6, continue next by measuring for voltage on ground side.

Continued on next page...

3. Normal voltage should measure 0.0–0.5 volts. If battery voltage is measured on ground side, a poor connection or broken wire/cable is indicated. Test the wires connecting the component for continuity. Replace faulty component or section of wire harness.

High Resistance

Measurements taken from a multimeter can be used to troubleshoot for unwanted resistance. Use the meter to test for lower than normal battery voltage (voltage drop) while moving to accessible points in the circuit wiring. Replace section of failed wire harness. Refer to the diagram on page 3B-2.

Short Circuit Test

1. Test for a short in the circuit. When testing the circuit for a short, turn the ignition switch OFF and set the multimeter to measure resistance (ohms). Work through the circuit, if the meter measures resistance through the complete circuit, it may be an intermittent problem causing the short. In that case, repeat the procedure and move the wiring harness or tap on components while watching for a sudden drop in resistance Ω

   Expected result: If the voltage side of the circuit is shorted to ground, the meter will read 0.0Ω This indicates there is no resistance between check points (a dead short). Work through the circuit until the short is located. When the short is removed, the meter will return to a resistance reading.

2. Repair or replace faulty component or section of wire harness. Check circuit for function.

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Chapter 3: Power Distribution Subsystem

Section C: Repair

SUMMARY

The Power Distribution subsystem repair consists of standard maintenance, such as:

- replacing fuses
- cleaning battery terminals
- replacing batteries

Refer to the T655III Trencher *Maintenance Manual* for information.

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Chapter 4—Fluid Conditioning Subsystem

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Chapter 4: Fluid Conditioning Subsystem

Section A: Theory

OVERVIEW

The Fluid Conditioning subsystem consists of hydraulic components that are common to all machine subsystems. These components are involved in the supply, conditioning, and return of the oil required by the hydraulic system.

Circuits/Components

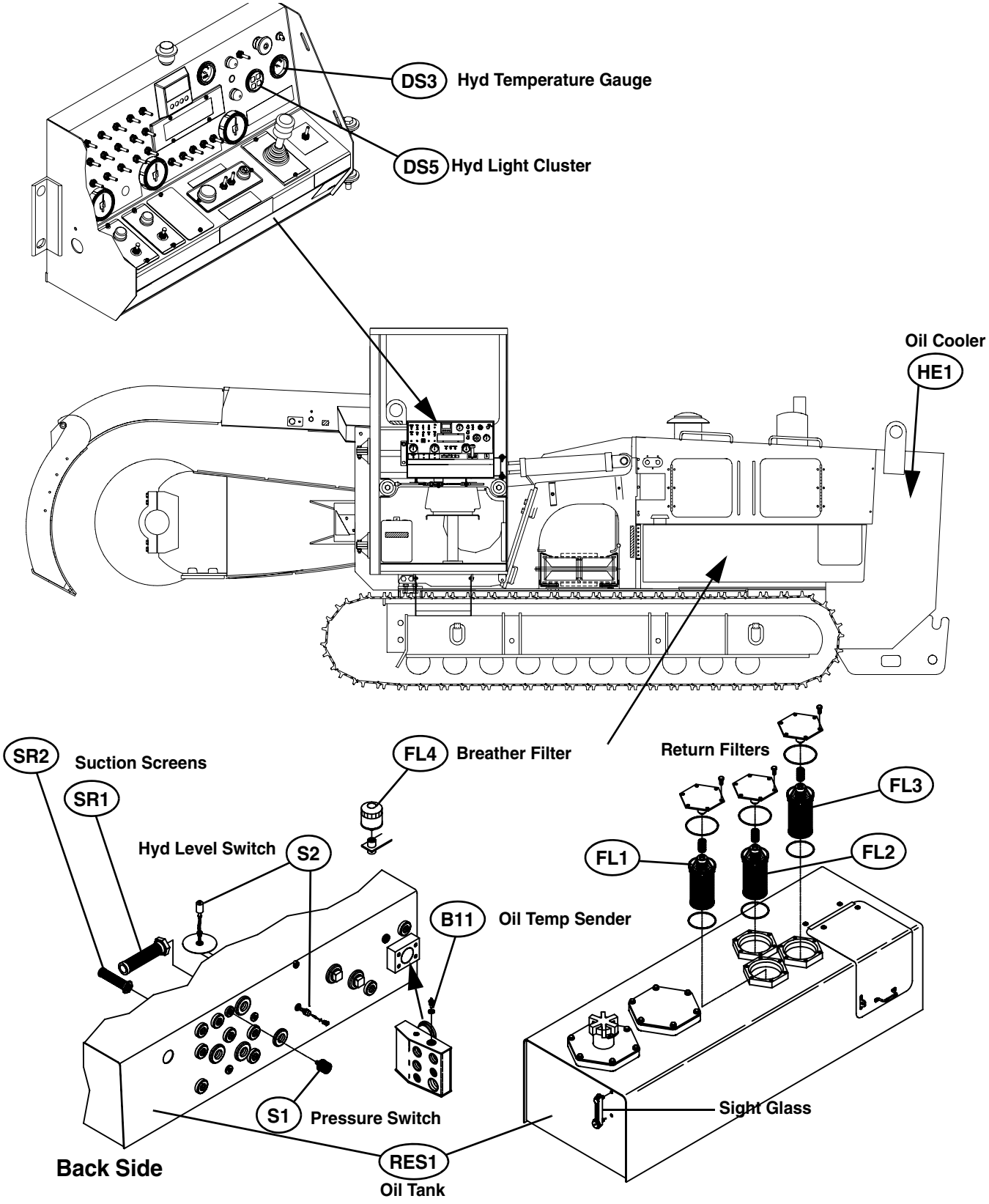
The following circuits and components are used in the Fluid Conditioning subsystem.

Hydraulic Oil Supply and Return Circuits:

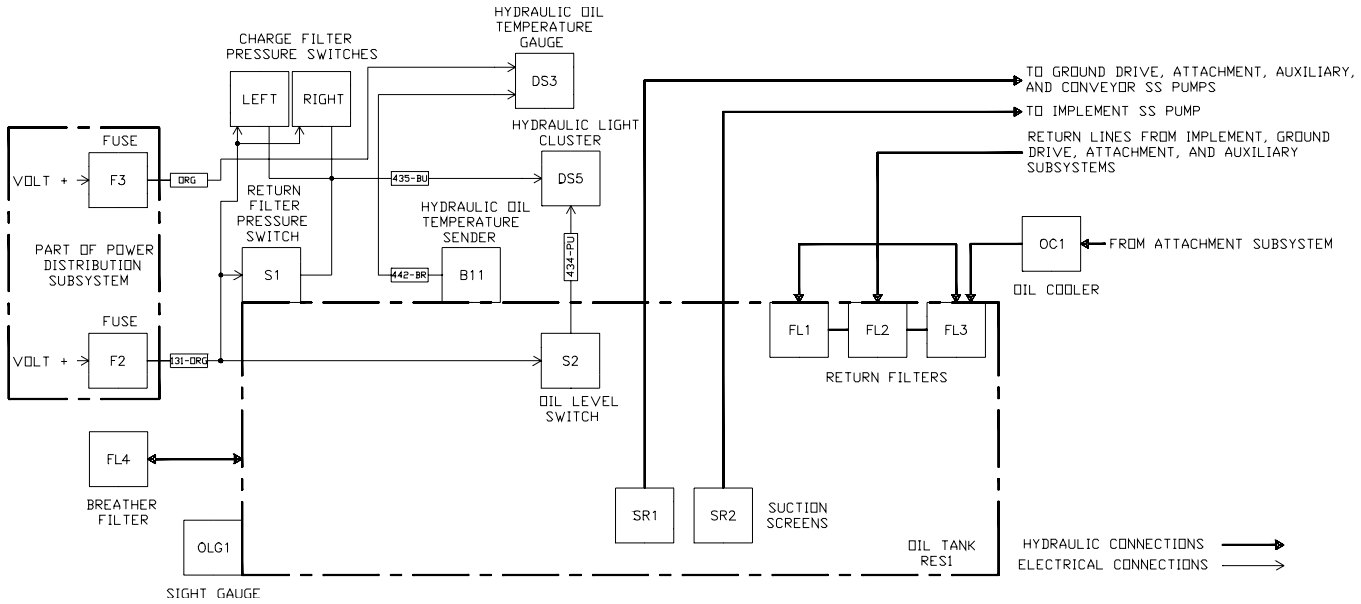
Hydraulic Tank RES1
Suction Screens SR1 & SR2
Return Filters FL1–FL3
Breather Filter FL4
Oil Cooler HE1
Plugged Filter Pressure Switch S1
Oil Level Switch S2
Oil Temperature Sender B11
Hydraulic Light Cluster DS5

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Component Locations



OIL SUPPLY AND RETURN CIRCUITS



Operation

The 85 gal (320 L) capacity hydraulic tank RES1, supplies and receives hydraulic oil necessary for operation of all hydraulic subsystem circuits.

A remote-mounted breather filter FL4 is plumbed into the tank to allow filtered air in and out of the tank during machine operation. When pressure in the tank reaches 5 psi (34 kPa), the normally closed relief valve inside the filter will open and release pressure to atmosphere.

The two 200-mesh (74-micron) suction screens SR1 & SR2 are installed inside the hydraulic tank. Once the engine is powered-up, hydraulic oil is drawn, (sucked) from the tank through the strainers. The strainers protect the pumps from dirt particles that may reside in the tank. The strainers and pumps they serve are as follows:

- SR1 - Ground Drive subsystem pump, Attachment subsystem pump, Auxiliary subsystem pump, and Conveyor subsystem pump.
- SR2 - Implement subsystem pump.

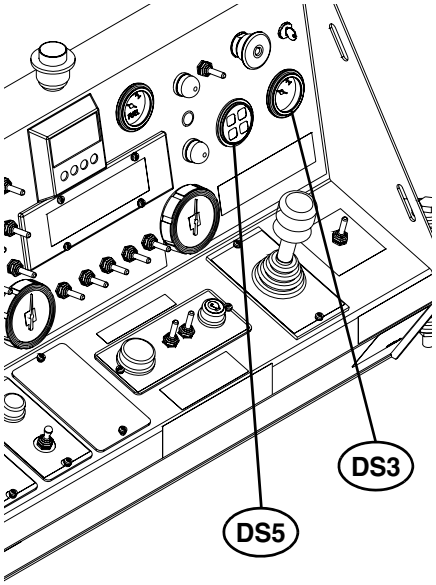
The subsystem pumps distribute pressurized oil flow to the different hydraulic subsystem circuits. As oil is returned to tank it is filtered through three 6-micron return filters FL1–FL3.

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A plugged filter pressure switch S1 installed in the tank, is designed to limit back pressure of hydraulic oil returning to the tank. The normally open switch gets power from a 5-amp fuse F2. During normal operation, if back pressure is above 20 psi (138 kPa), the switch will close, indicating filters are plugged. Springs located on filter frames will allow the filter to move and oil to bypass straight into tank.

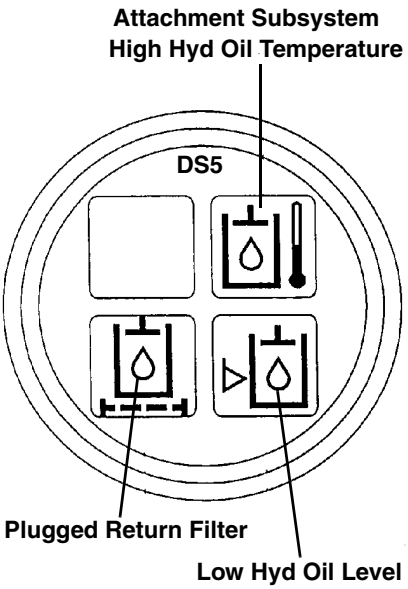
Once the switch is closed, a signal is sent to the hydraulic light cluster DS5. The plugged oil filters LED will illuminate to warn the operator.



Under normal operation, the indicator LED may illuminate when operating with cold oil. If the indicator light remains on after the oil reaches normal operating temperature, the filters are being bypassed and should be serviced.

The oil level switch S2 located inside the oil tank, monitors the level of oil during operation. The normally open switch gets power from a 5-amp fuse F2 and will close if the oil level drops below add mark on sight gauge OLG1. When switch closes, a signal is sent to the hydraulic light cluster DS5 located on the control panel. The oil level low indicator LED will illuminate to warn the operator.

The hydraulic temperature sender B11, installed in the hydraulic tank suction manifold, monitors the oil temperature during operation. The sender relays a signal to the analog gauge DS3 installed on the control panel. The gauge gets power from a 10-amp fuse F3 and will register the temperature of the oil.



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The Attachment subsystem utilizes an oil cooler HE1 in the return circuit. The oil cooler is considered part of the Fluid Conditioning subsystem because it cools the hydraulic oil which is common to all subsystem hydraulic circuits. The Attachment subsystem also utilizes the hydraulic light cluster to indicate high case drain oil temperature.

NOTE: For more operating information on the Attachment subsystem, refer to Theory chapter 8A.

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Chapter 4: Fluid Conditioning Subsystem

Section B: Troubleshooting

OVERVIEW

Refer to “Fluid and Lubricants”, *page 2-7* for correct fluid requirements. This section discusses the shared hydraulic components. These are the components necessary for all machine hydraulic functions to operate. If machine performance indicates problems in more than one subsystem or circuit, or if troubleshooting efforts for a single subsystem fail to find a problem, components common to the afflicted circuits need to be investigated.

Possible Malfunctions

Multiple subsystems and circuits experience malfunctions or abnormal behavior such as:

- Actuator operation is erratic when operating any of the subsystems.
- There is excessive heat when operating any of the subsystems.
- There is excessive noise, vibration, coming from pumps.
- There is excessive oil leakage.

Troubleshooting of the fluid conditioning components consists of checks and inspections based on the observations noted above:

Test Equipment Needed

- Pyrometer or magnetic or dial thermometer with magnetic base.
- Basic wrenches for tightening or loosening fittings.

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OIL SUPPLY AND RETURN CIRCUITS

Excessive Noise

Excessive noise associated with hydraulic systems may come from a pump or pumps cavitating or sucking air. Another source of excessive noise may be a relief valve that is faulty or set incorrectly.

The most pronounced indication of a pump either cavitating or sucking air are high pitched sounds. A cavitating pump will have a steady, high pitched sound. A pump sucking air will have somewhat of an erratic sound. A noisy relief valve will have a steady high pitched screeching noise.

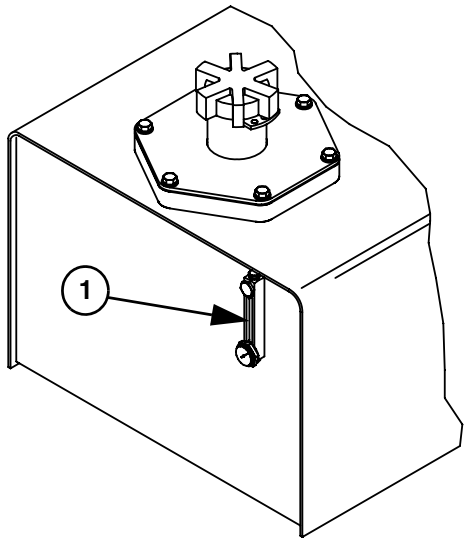
Cavitation is the formation of gaseous cavities in the liquid. Cavitation will interfere with lubrication and destroy metal surfaces in the pump. If allowed to continue, the pump will ultimately fail and contaminate the entire system. Cavitation can be caused by restricted oil flow at the inlet of pumps or if air is allowed to enter the inlet port of pumps.

Along with excessive noise, there are some other symptoms of cavitation to be aware of:

- A moderate to high increase in the operating temperature of the oil.
- Erratic actuator operation.
- Air contamination of the oil (foaming).

Noise Associated with a Pump

If excessive noise is associated with pumps:

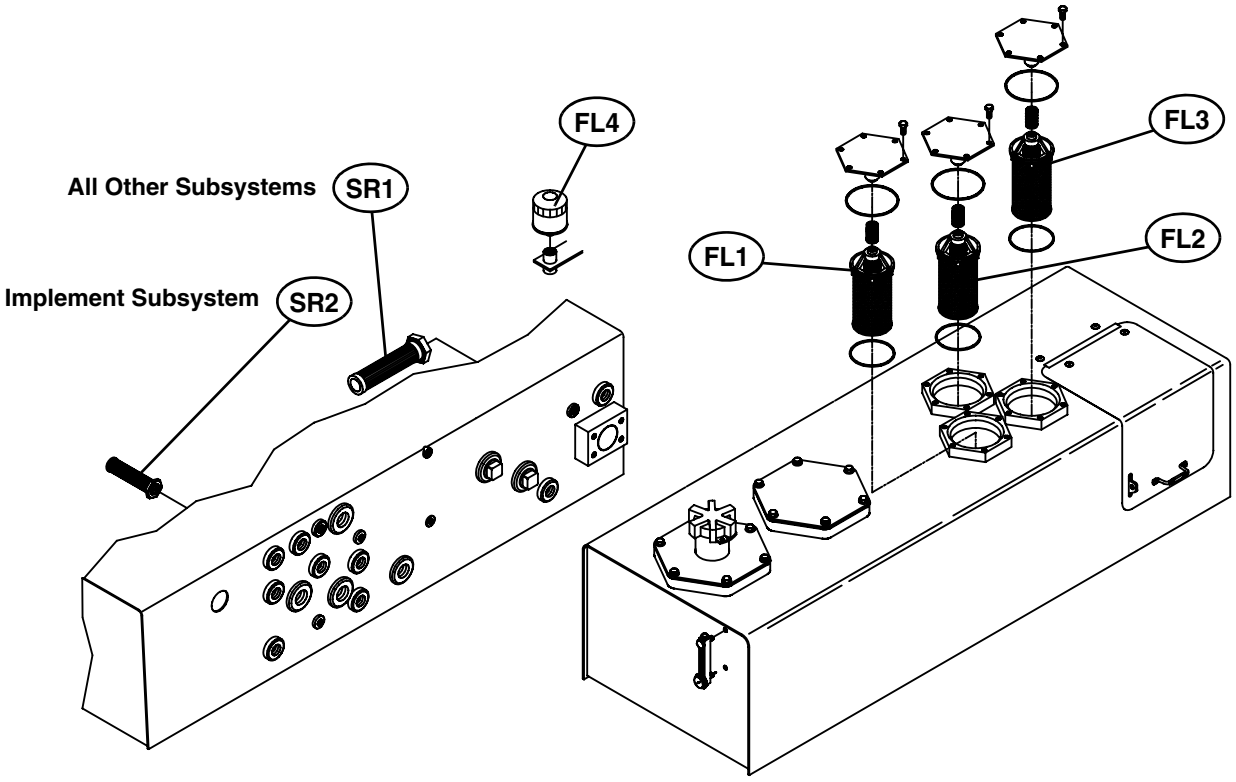


1. Check level of the oil in the tank. Observe the sight gauge **(1)** on the hydraulic tank. The level of the oil should be visible in the sight glass. If not, filter new oil through a 10-micron filter before adding it to the tank.
2. Check for air in the system. If air is entering the system, inspect, suction lines for loose connections, leaking connections, hose deterioration, pump seal leakage, Repair or replace as necessary. If OK, continue with step 3 and check for cavitation.

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3. Check for cavitation in the system. Inspect breather filter for clogs, suction strainers for clogs, (see filtering below) restriction or collapse in suction line. Repair or replace as necessary.



Filtering

When activating a machine function, large amounts of oil will flow through the return filters FL1–FL3 to the tank. If a filter becomes restricted enough to raise the pressure to 22 psi (152 kPa), a bypass valve will open in the filter head and allow unfiltered oil into the tank. Unfiltered oil will eventually damage system components.

The tank outlet suction strainer screens SR1 & SR2 must be clean. If a pump squeals when pumping oil, sufficient oil may not be reaching the inlet of the pump, implying the strainer screen in the tank is clogged or that the suction hose is partially collapsed. Any reduction of flow to the pumps can cause cavitation which will make the pumps squeal. This can severely damage the pump in a short time.

IMPORTANT: If suction strainer SR1 feeding a closed-loop system pump becomes clogged, sufficient charge pressure may not be obtained, causing the system to malfunction.

NOTE: Refer to the *Maintenance Manual* for information on replacing filters or cleaning and replacing the screens.

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Noise Associated with a Relief Valve

NOTE: Subsystems with closed-loop hydraulic systems have relief valves that are integral to the pumps.

If excessive noise is associated with a relief valve (screeching or screaming noise): Refer to the subsystem troubleshooting for pump or relief valves making noise.

Excessive Vibration

Excessive vibration can be caused by worn pump drives, loose, worn, or unbalanced couplings and mounts to pumps. Excessive vibration can also come from air in the system or hydraulic lines if support clamps are broken or loose.

1. Inspect drive mechanism and pump mounts. Inspect hydraulic line clamps for wear, loose connections, and broken parts. If any are found, repair or replace.
2. Check for air in the system. Refer to instructions on page 4B-2.

Excessive Heat

Inefficiency in the form of heat can be expected in all hydraulic systems. The temperature of the oil should not exceed 180°F (82°C) during normal work cycles. If it remains warmer than this, search for the cause. Rapid increases in temperature (from ambient to above maximum allowable) is usually caused by oil flowing through a restriction (such as an internal leak). Internal leakage in components creates heat.

NOTE: Refer to engine subsystem chapter page 5B-13 for troubleshooting information on hydraulic tank oil temperature gauge and sender.

1. Check oil level in tank. Refer to page 4B-2 for more information on checking and adding oil. Use a pyrometer or a dial thermometer with a magnetic base to measure the temperature of the external walls of the oil tank. If using a dial thermometer, ensure it is located below the level of the oil in tank. If oil temperature is above design specification, continue.

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Oil Cooler and Thermal Bypass Valves

2. Inspect oil cooler for debris or damage that may be blocking air flow through coolers. If damaged repair or replace.
3. Use a pyrometer to check the temperature on the inlet and outlet ports of oil cooler for a temperature differential while the attachment drive is rotating. If there is not a temperature differential, the cooler may be partially obstructed internally or a thermal bypass valve may be faulty.
4. Use a pyrometer to check the temperature at the inlet and outlet of the thermal bypass valves. If a valve is stuck closed, the oil will go straight to tank. If so, replace valve. If OK, replace cooler.
5. In some cases it may be possible to use a pyrometer to follow hoses or drain lines upstream from the tank to the source of the heat. The pyrometer readings should increase or maintain temperature to the restriction, then decrease dramatically as it is moved upstream from the restriction. If the problem is found, refer to the appropriate subsystem troubleshooting procedures for instructions.
6. Check for air in the system. Refer to page 4B-2 for more information.

Hydraulic Oil Sampling

Once a subsystem/circuit problem is found and the required repairs have been made, inspect the condition of the oil by taking a sample before returning the machine to work. Remove the cap and smell hydraulic oil. The oil should have a bland or non-descript odor. If the oil smells burnt or has a pungent odor, heat or oxidation may have ruined the oil.

Draw and inspect a sample of the oil and compare it to a sample of new oil. The fluid should appear clean, clear and amber in color. A milky haze or smoky appearance indicates there is water in the oil. The water should settle out in 24 hours. If not, replace fluid and filters. Refer to the T655III *Maintenance Manual* for details.

Further sampling of the hydraulic oil should be performed after repairing a closed loop system or implement circuit to determine levels of particles of dirt and metals in the oil. Samples should be taken using an automatic, portable particle counter which uses light obscuration technique. The particle counter must be able to display ISO codes at 4/6/14 micron level and also be able to produce a hard copy of data. The equipment must also be rated for at least 6000 psi (414 bar).

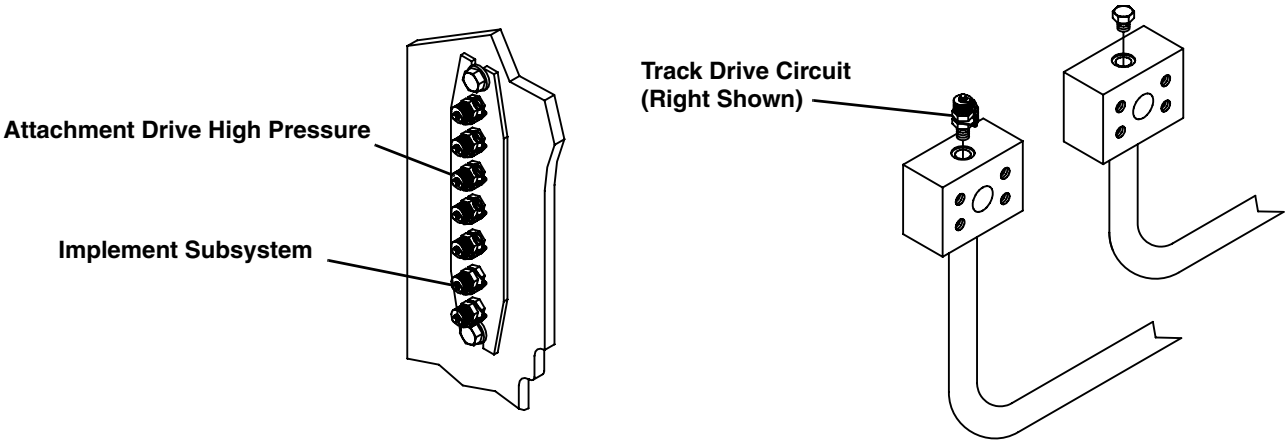
NOTE: If not equipped with this type of sampling machine, oil samples must be sent to a qualified testing facility to determine the condition.

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Oil Sampling Criteria

- Ensure hydraulic oil temperature is at least 100°F (38°C). Warm the oil by running the tracks or trencher or both.
- The engine speed must be set to low idle.
- All components in the hydraulic circuit that the sample is being taken from must be connected and pump(s) on full stroke.



Sample Collection Points:

- To sample Track Drive Circuits, use the left and right track high pressure diagnostic ports located on the track frame tubes.
- To sample the Attachment Drive Circuit, use the attachment high pressure diagnostic port located on the side of machine.
- To sample the Implement Circuits, use the implement diagnostic port located on side of machine.
- To sample the tank oil, remove the oil tank fill cap and draw a sample directly from the tank.

Cleanliness Approval Criteria:

- Oil sample must be at 4/6/14 micron ISO code of 18/16/13 or less to pass.
- If a hydraulic tank or implement circuit sampling is above ISO code 18/16/13, the hydraulic fluid and filters should be replaced. Refer to the T655III *Maintenance Manual* for instructions.
- If sample is above ISO code 18/16/13 when sampling the attachment or track drive circuits, high pressure closed-loop filtration must be installed and operated for 15 minutes, then resampled. Install the filter kit IK-349 on the circuit which has been sampled. Refer to kit instructions to flush the system.

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- If sample is still above ISO code 18/16/13, the hydraulic fluid and filters should be replaced. Refer to the T655III *Maintenance Manual* for instructions.





WARNING: Pressurized fluid can penetrate body tissue and result in serious injury or death. Leaks can be invisible. Keep away from any suspected leak. Relieve pressure in the hydraulic system before searching for leaks, disconnecting hoses, or performing any other work on the system. If you must pressurize the system to find a suspected leak, use an object such as a piece of wood or cardboard rather than your hands. When loosening a fitting where some residual pressure may exist, slowly loosen the fitting until oil begins to leak. Wait for leaking to stop before disconnecting the fitting. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

Oil Leakage

If enough leakage occurs, the oil level in the hydraulic tank will continue to drop to dangerous levels if the source of the leak is not found and corrected. If it cannot be determined where the leak has originated from by simply walking around the machine and visually inspecting, then clean the machine to try and locate the leak. If the leak is found, repair or replace the component or hydraulic supply or return line that is faulty.

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Chapter 4: Fluid Conditioning Subsystem

Section C: Repair

SUMMARY

The Fluid Conditioning subsystem repair consists of standard maintenance, such as:

- replacing hydraulic fluid
- replacing hydraulic charge and return filters
- replacing breather filters
- cleaning and replacing suction screens in tank

Refer to the T655III Trencher *Maintenance Manual* for information.

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Chapter 5—Engine Subsystem

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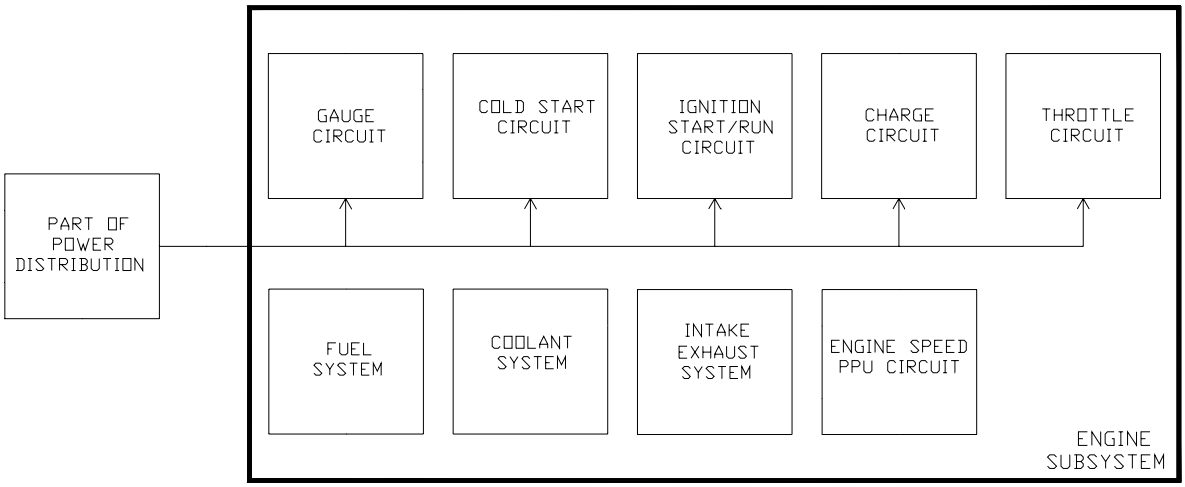
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Chapter 5: Engine Subsystem

Section A: Theory

OVERVIEW

MAP



Lines and arrows on the MAP illustrate the interdependencies of the subsystems. The power distribution subsystem supplies input necessary for operation.

The Engine subsystem consists of the engine and associated systems. The electrical circuits of the subsystem are responsible for engine START/RUN, battery charging, cold start operation. The engine control unit and gauges monitor and indicate engine operating parameters.

Circuits/Components

The following systems, circuits, and components are used in the engine subsystem.

Engine ENG1

PowerView/Engine Control Unit ECU

Engine Speed PPU Circuit:

Magnetic Pickup PPU B10

Throttle Circuit:

Throttle Switch S35

Continued on next page...

Cold Start Circuit:

Ether Switch S15
Ether Solenoid L4

Coolant Circuit:

Radiator

Intake/Exhaust Circuit:

Air Cleaner/Indicator
Turbocharger
Muffler/Exhaust

Fuel Circuit:

Fuel Tank RES2
Suction Strainers SR1
Fill Strainer SR2
Breather FL10
Fuel Lines
Primary Fuel Filter FL11
Secondary Fuel Filter FL12

Ignition START/RUN Circuit:

Starter M1
Start Relay K2
Fuel (Run) Relay K1

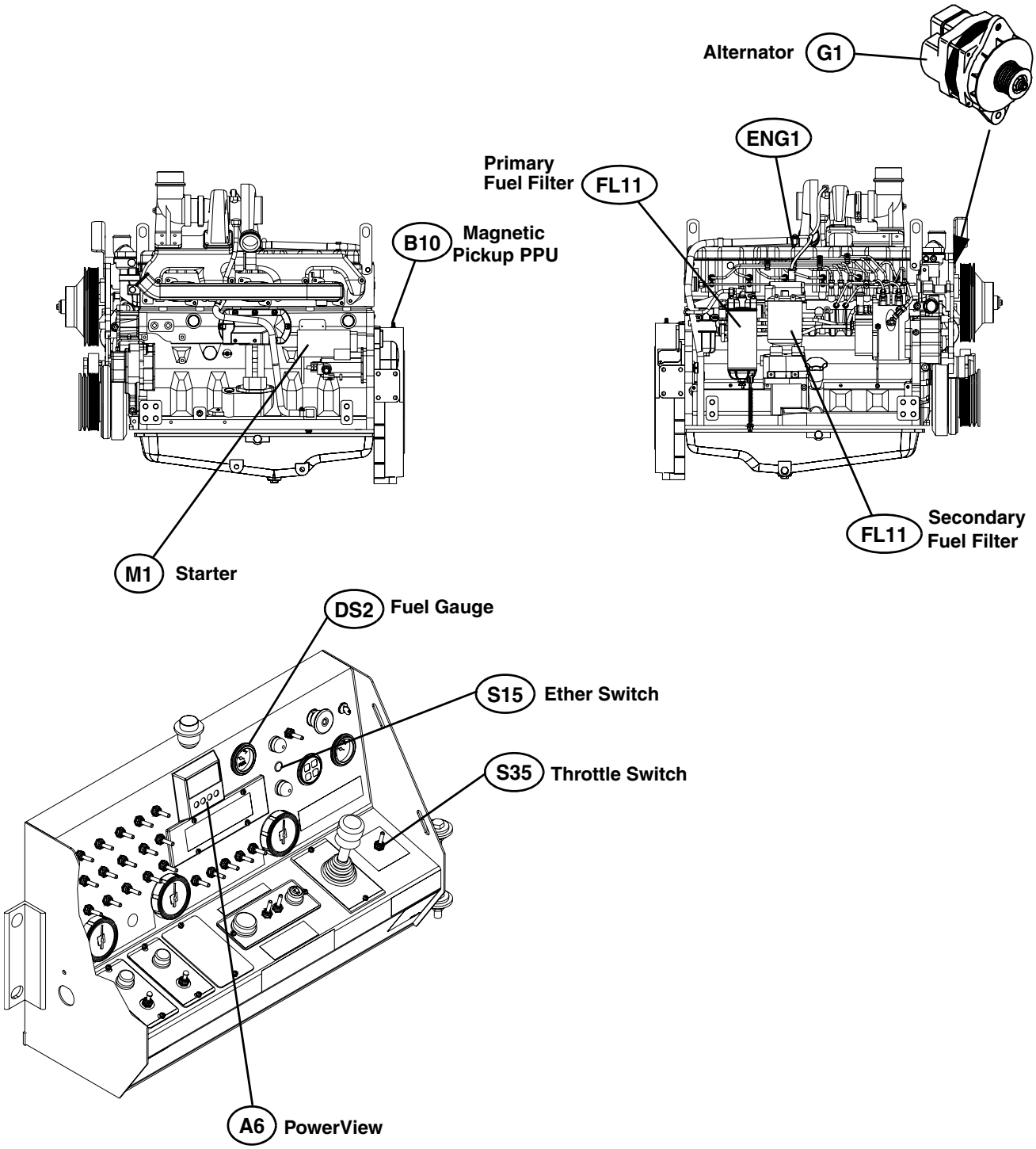
Charge Circuit:

Alternator G1

Gauge Circuit:

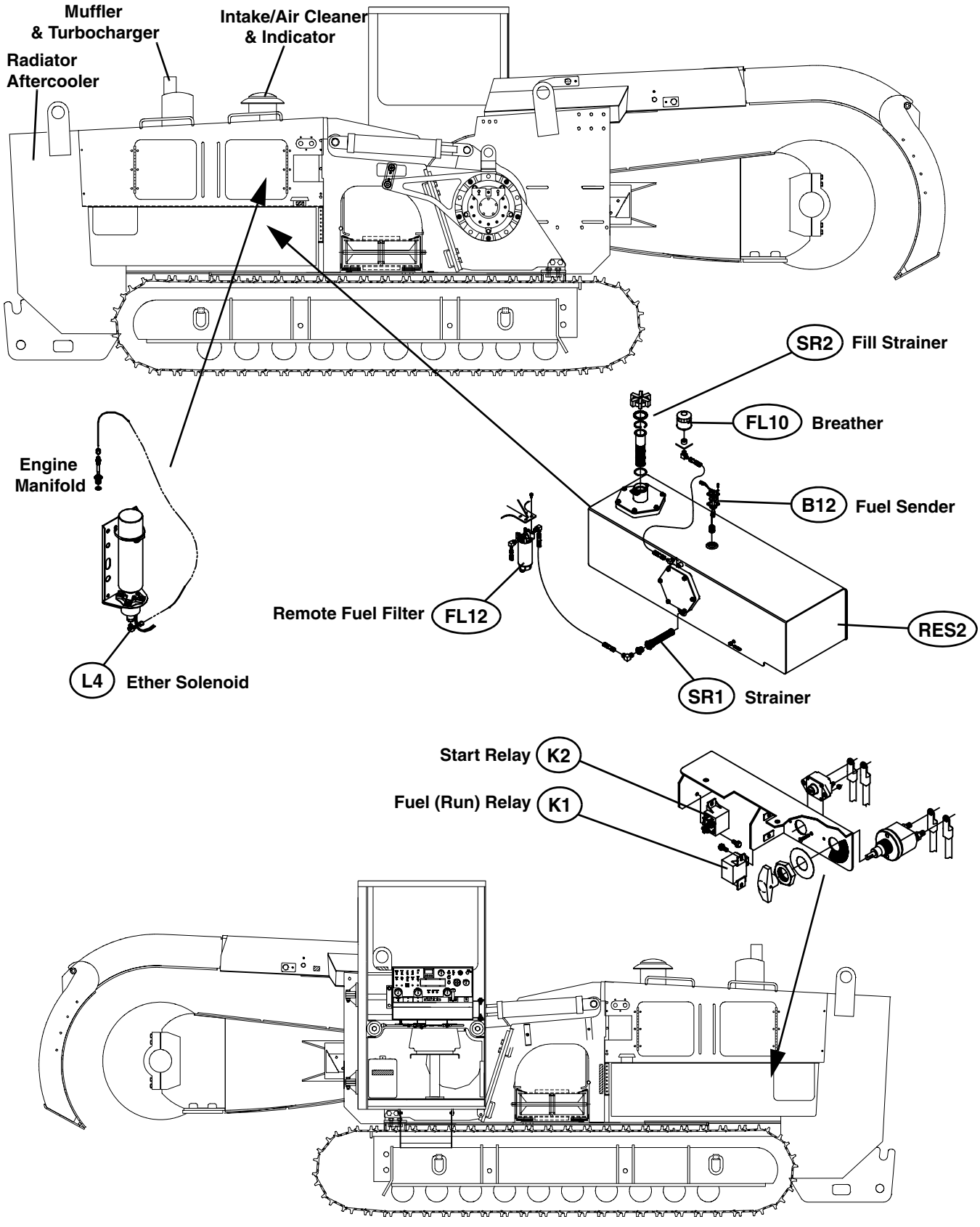
Fuel Gauge DS2
Fuel Sender B12

Component Locations

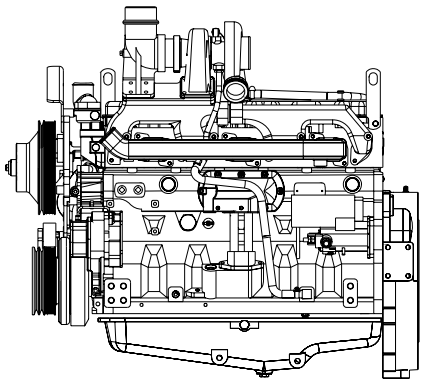


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ENGINE ENG1



The in-line 6-cylinder water-cooled John Deere model 6090 HF485 diesel engine with turbocharger produces 250 hp (186 kW) at rated engine speed of 2200 rpm.

The engine operates at approximately 800 rpm at low idle and 2350 rpm at full throttle.

The engine supplies the pump drive assembly installed on the output side (rear of the engine) with power. The pump drive rotates four 90-series pumps used to supply hydraulic oil flow to the Ground Drive and Attachment subsystems.

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ENGINE CONTROL UNIT

Engine Electronic features are controlled by an integral on-board computer. Current operating conditions are monitored and the Electronic Control Unit tells the engine how to respond to the conditions and the demands of the operator. These conditions and operator demands determine the ECU's precise control of fuel injection.

The engine monitoring system called PowerView A6, is located on the machine control panel assembly.

The digital display shows the various engine parameters. It receives information from the engine's electronic control unit ECU and sensors.

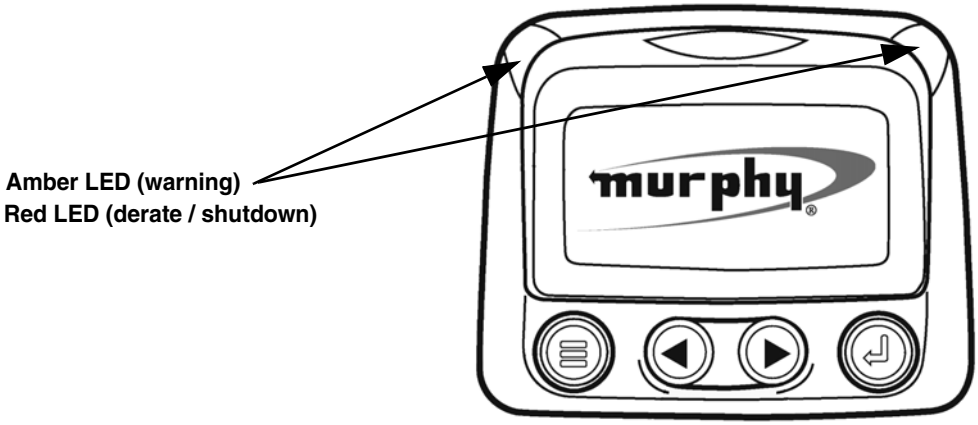
The ECU receives input from several sensors installed on the engine and displays them on the PowerView A6.

NOTE: These sensors are considered part of the engine and are covered under John Deere's warranty. You can void this warranty by attempting to repair the engine before the warranty has lapsed. If the warranty is still in effect, take engine to an authorized John Deere Service Facility.

Engine Shutdown

Engine monitoring determines the level of action taken by the ECU in response to a potentially engine damaging condition recognized by the different engine sensors. Some parameters, when exceeded, will cause the engine to shut down.

MURPHY POWERVIEW



The Murphy PowerView is a diagnostic tool that is used to provide the operator with critical information about the engine. The PowerView is essentially the user interface to the engine microcontroller.

For more information about how to use the PowerView display, refer to the T655III *Operator's Manual*.

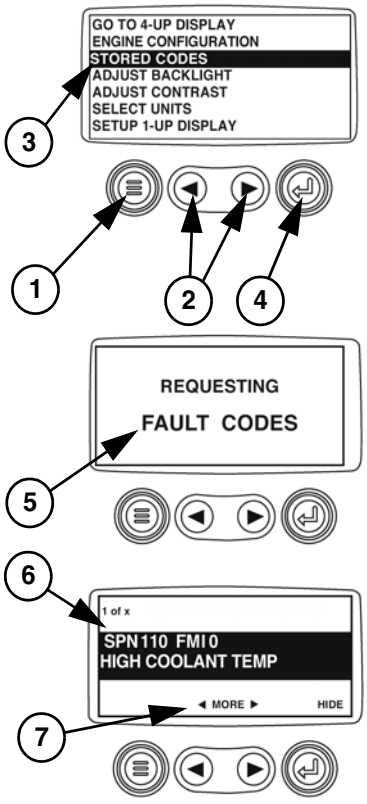
Accessing Engine Fault Codes (PowerView)

To access stored fault codes, proceed as follows:

1. Press the menu key **(1)** and use the arrow keys **(2)** to highlight "STORED FAULT CODES" **(3)**. Press the enter key **(4)**.
2. Wait for the display while it searches for stored fault codes **(5)**.

NOTE: If no faults are found, the display will return to the Main Menu. Otherwise, the faults will be displayed with a description as shown **(6)**. If more than one fault is stored, the word "MORE" will appear at the bottom of the display **(7)**.

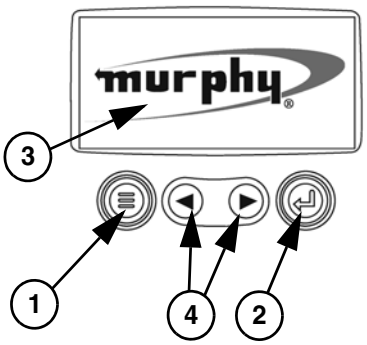
3. If more than one fault is stored, use the arrow keys **(2)** to scroll through them.



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Clearing Engine Fault Codes (PowerView)

To clear stored fault codes, proceed as follows:



1. Power up the module and watch for the logo start-up screen **(3)**. When the logo appears on the screen, press menu key **(1)** and the enter key **(2)** simultaneously to activate the hidden menu.

NOTE: There is only a 1-second window from the time the logo appears in which the menu and enter keys must be pressed.

2. Once in the hidden menu, use the arrow keys **(4)** to highlight “CLEAR FAULT CODES”. Press enter key **(2)**.
3. The display should read “FAULT CODES CLEARED”.

NOTE: When in the hidden menu, be careful not to restore the PowerView to Factory Defaults. Factory Defaults **do not** include configuration settings for the machine the PowerView has been installed on.

4. Cycle power to the unit once the codes have been cleared.

Interpreting John Deere Engine Fault Codes

There are two components of a John Deere fault code.

- SPN (Suspect Parameter Number)
- FMI (Failure Mode Identifier)

The table below lists a description for each fault code.

John Deere Engine Fault Codes

SPN	FMI	Description
28	03	Throttle Voltage High
28	04	Throttle Voltage Low
29	03	Throttle Voltage High
29	04	Throttle Voltage Low
29	14	Throttle Voltage Out of Range
84	02	Vehicle Speed Mismatch
84	09	Vehicle Speed Invalid or Missing
91	03	Throttle Voltage High
91	04	Throttle Voltage Low
91	08	PWM Throttle Abnormal Pulse Width
91	09	Throttle Invalid
91	14	Throttle Voltage Out of Range
94	01	Fuel Rail Pressure Extremely Low
94	03	Fuel Rail Pressure Input Voltage High
94	04	Fuel Rail Pressure Input Voltage Low
94	10	Fuel Rail Pressure Loss Detected
94	13	Fuel Rail Pressure Higher Than Expected
94	17	Fuel Rail Pressure Not Developed
94	18	Fuel Rail Pressure Moderately Low
97	00	Water in Fuel Continuously Detected
97	03	Water in Fuel Signal Voltage High
97	04	Water in Fuel Signal Voltage Low
97	16	Water in Fuel Detected
97	31	Water in Fuel Detected
100	01	Engine Oil Pressure Extremely Low
100	03	Engine Oil Pressure Input Voltage High
100	04	Engine Oil Pressure Input Voltage Low
100	18	Engine Oil Pressure Moderately Low
102	03	Manifold Air Pressure Input Voltage High
102	04	Manifold Air Pressure Input Voltage Low
105	00	Manifold Air Temperature Extremely High
105	03	Manifold Air Temperature Input Voltage High
105	04	Manifold Air Temperature Input Voltage Low
105	16	Manifold Air Temperature Moderately High
107	00	Air Filter Differential Pressure

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John Deere Engine Fault Codes (Continued)

SPN	FMI	Description
110	00	Engine Coolant Temperature Extremely High
110	03	Engine Coolant Temperature Input Voltage High
110	04	Engine Coolant Temperature Input Voltage Low
110	15	Engine Coolant Temperature High Least Severe
110	16	Engine Coolant Temperature Moderately High
110	31	Engine Coolant Temperature High
111	01	Engine Coolant Level Low
158	17	ECU Power Down Error
160	02	Wheel Speed Input Noise
174	00	Fuel Temperature High Most Severe
174	03	Fuel Temperature Input Voltage High
174	04	Fuel Temperature Input Voltage Low
174	15	Fuel Temperature High Least Severe
174	16	Fuel Temperature High Moderately Severe
189	00	Engine Speed Derate
189	31	Engine Speed Derate
190	00	Engine Overspeed Extreme
190	16	Engine Overspeed Moderate
237	02	Vehicle Identification Number Invalid
237	13	Vehicle Identification Option Code Invalid
237	31	Vehicle Model Number Invalid
523	09	Gear Selection Invalid
611	03	Electronic Injector Wiring Shorted to Power Source
611	04	Electronic Injector Wiring Shorted to Ground
620	03	Sensor Supply Voltage High
620	04	Sensor Supply Voltage Low
627	01	Electronic Injector Supply Voltage Problem
627	04	ECU Unswitched Power Missing
629	13	ECU Error
629	19	ECU to Pump Communication Error
632	02	Fuel Shutoff Error
632	05	Fuel Shutoff Non-Functional
636	02	Pump Position Sensor Input Noise
636	08	Pump Position Sensor Input Missing
636	10	Pump Position Sensor Input Pattern Error
637	02	Crank Position Input Noise
637	07	ECU/Pump Timing Moderately Out of Sync
637	08	Crank Position Input Missing
637	10	Crank Position Input Pattern Error
639	13	CAN Bus Error
640	11	Engine Shutdown Vehicle Request Invalid

John Deere Engine Fault Codes (Continued)

SPN	FMI	Description
640	31	Engine Shutdown Vehicle Request
651	05	Cylinder #1 Electronic Injector Circuit Open
651	06	Cylinder #1 Electronic Injector Circuit Shorted
651	07	Cylinder #1 Electronic Injector Mechanical Failure
652	05	Cylinder #2 Electronic Injector Circuit Open
652	06	Cylinder #2 Electronic Injector Circuit Shorted
652	07	Cylinder #2 Electronic Injector Mechanical Failure
653	05	Cylinder #3 Electronic Injector Circuit Open
653	06	Cylinder #3 Electronic Injector Circuit Shorted
653	07	Cylinder #3 Electronic Injector Mechanical Failure
654	05	Cylinder #4 Electronic Injector Circuit Open
654	06	Cylinder #4 Electronic Injector Circuit Shorted
654	07	Cylinder #4 Electronic Injector Mechanical Failure
655	05	Cylinder #5 Electronic Injector Circuit Open
655	06	Cylinder #5 Electronic Injector Circuit Shorted
655	07	Cylinder #5 Electronic Injector Mechanical Failure
656	05	Cylinder #6 Electronic Injector Circuit Open
656	06	Cylinder #6 Electronic Injector Circuit Shorted
656	07	Cylinder #6 Electronic Injector Mechanical Failure
729	03	Inlet Air Heater Signal High
729	05	Inlet Air Heater Signal Low
810	02	Calculated Vehicle Speed Input Noise
898	09	Vehicle Speed Invalid/Missing
970	02	Engine Shutdown - Auxiliary Signal Invalid
970	31	Engine Shutdown - Auxiliary Request
971	31	External Fuel Derate Switch Active
1069	02	Tire Size Error
1069	09	Tire Size Invalid
1069	31	Tire Size Error
1077	07	Attempting to Fuel Without Command
1077	11	Pump Supply Voltage Out of Range
1077	12	Pump Self Test Error
1077	19	Pump Detected Communication Error
1077	31	Pump Initiated Engine Protection
1078	07	ECU/Pump Timing Moderately Out of Sync
1078	11	ECU/Pump Speed Out of Sync
1078	31	ECU/Pump Timing Extremely Out of Sync
1079	03	Sensor Supply Voltage High
1079	04	Sensor Supply Voltage Low
1080	03	Fuel Rail Pressure Sensor Supply Voltage High
1080	04	Fuel Rail Pressure Sensor Supply Voltage Low

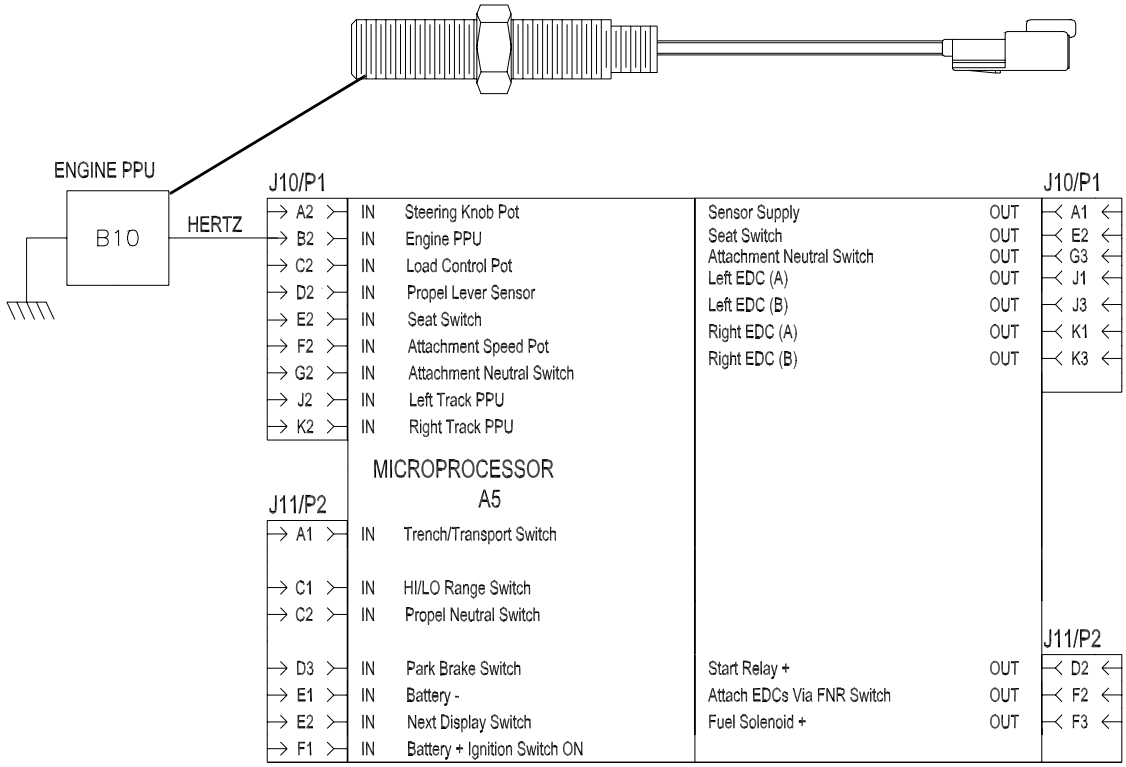
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John Deere Engine Fault Codes (Continued)

SPN	FMI	Description
1109	31	Engine Protection Shutdown Warning
1110	31	Engine Protection Shutdown
1347	05	Pump Control Valve #1 Error
1347	07	Fuel Rail Pressure Control Error
1347	10	Pump Control Valve #1 Fuel Flow Not Detected
1348	05	Pump Control Valve #2 Error
1348	10	Pump Control Valve #2 Fuel Flow Not Detected
1485	02	Pump Power Relay Fault
1568	02	Torque Curve Selection Invalid
1568	09	Torque Curve Selection Missing
1569	31	Fuel Derate
1639	01	Fan Speed Signal Missing
1639	02	Fan Speed Signal Erratic
1639	16	Fan Speed Higher Than Expected
1639	18	Fan Speed Lower Than Expected
2000	09	Vehicle ID Missing
2000	13	Security Violation
2005	09	ACU Signal Missing
2049	09	CAB Signal Missing
2071	09	CCU Signal Missing

ENGINE SPEED PPU CIRCUIT



Magnetic Pickup PPU

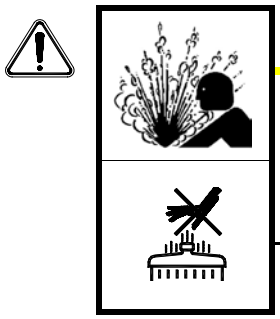
The magnetic pickup PPU B10 is grounded by the machine chassis and supplies a frequency input, in hertz, to the microprocessor. The PPU tells the microprocessor what speed the engine is turning.

The following formula is used to determine the hertz.

- Number of teeth on the flywheel *multiplied* by engine RPM *divided* by 60
- (low idle) - 129 x 800 rpm = 103,200 ÷ 60 = 1720 hertz
- (Full throttle) - 129 x 2350 rpm = 303,150 ÷ 60 = 5052.5 hertz

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COOLANT CIRCUIT



WARNING: Hot fluid under pressure can scald.

Allow engine to cool before opening radiator cap.

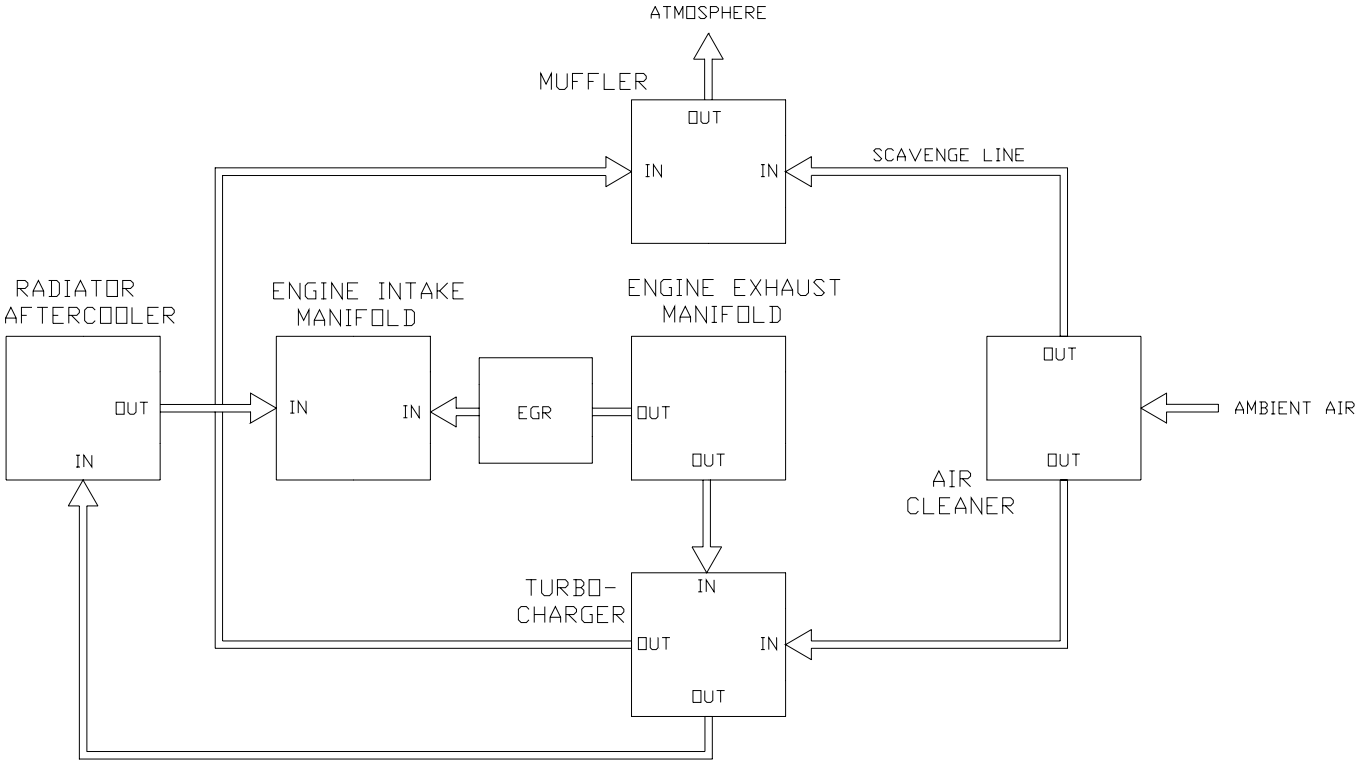
The coolant system includes the radiator and associated plumbing.

The total combined radiator and engine coolant capacity is 42.2 qt (40 L). Before starting the engine, check fluid level in the radiator. If low, fill radiator with a low-silicate (ethylene glycol) antifreeze and clean water mixture.

NOTE: Never add pure antifreeze to a cooling system. Vermeer recommends using a 50/50 mixture. Never use high-silicate antifreeze or antifreeze that is higher than 60/40 mixture.

NOTE: The radiator also incorporates an air to air aftercooler **(3)**. Refer to “Air Intake/Exhaust Circuit,” page 5A-15.

AIR INTAKE/EXHAUST CIRCUIT



Clean filtered air flow from the air cleaner enters the inlet cold air passage of the turbocharger. The exhaust gases from the engine exhaust manifold enter the hot air passage inlet of the turbocharger. The exhaust gasses cause a turbine and compressor wheel inside the turbo housing to spin. The spinning turbine wheel causes the compressor wheel to spin. This compresses the cool inlet air, increasing the density of the air.

The compressed air is forced through the outlet of the turbocharger into a pipe system connected to the inlet of the air to air aftercooler. The air is cooled and forced out of the aftercooler outlet through a similar pipe system and delivered into the engine intake manifold of the engine for combustion.

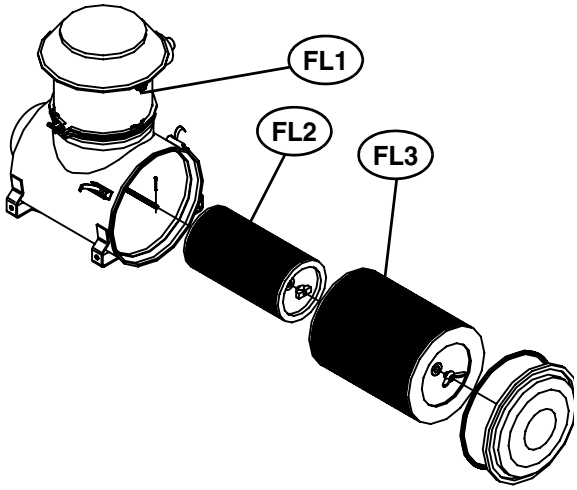
When the turbocharger compresses air, the air heats up reducing its density. The aftercooler cools it back down to increase density to get maximum benefit while adding extra boost in performance. The compressed air allows more fuel to be delivered to produce more power.

A scavenge line is connected from the air cleaner to the exhaust muffler. Dirt passes through the scavenging line to the muffler where it is ejected into the atmosphere by exhaust gases. A 1-way check valve in the scavenging line prevents engine exhaust gases from entering air cleaner.

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Air Cleaner

The air cleaner on the machine is designed to remove moisture, dirt, and dust from the air before it reaches the turbocharger.



The canister-type air cleaner on the machine has three stages: scavenger precleaner FL1, primary element FL3, and safety element FL2. The precleaner is installed at the top of the air cleaner inlet.

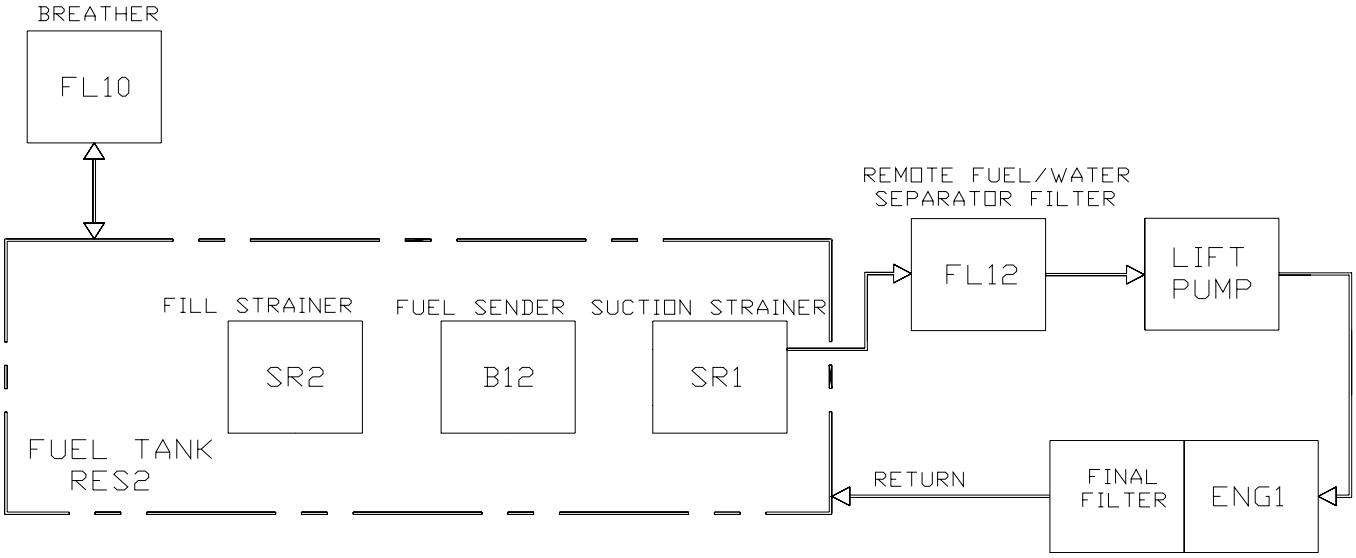
NOTE: The air cleaner is equipped with an air restriction indicator (not shown) mounted on the top of the control panel. The indicator gives the operator a visual indication of the condition of the primary element. Replace primary element when red indicator reaches the bottom of rectangle.

The safety or secondary element, is designed to trap any dirt that escapes the primary element. Refer to the T655III Trencher *Maintenance Manual* for information on replacing air cleaner elements.

The air cleaner should be visually inspected for any missing mounting hardware, cracked, broken, or missing hoses, connectors, or clamps before starting engine.

NOTE: Opening the air cleaner unnecessarily increases the chances of contaminants entering the engine.

FUEL CIRCUIT



As the engine turns over, the engine's fuel injector pump draws fuel from the 85 gal (320 L) tank RES2. The fuel tank is equipped with a suction strainer SR1 designed to capture any contaminates residing in the bottom of the tank as fuel is drawn by the fuel pump.

The fill cap assembly installed on top of the tank contains a strainer SR2 for capturing any contaminates that may be introduced during refueling. The tank also has a remote breather filter FL10 installed over the top of the tank designed to filter the ambient air entering the tank.

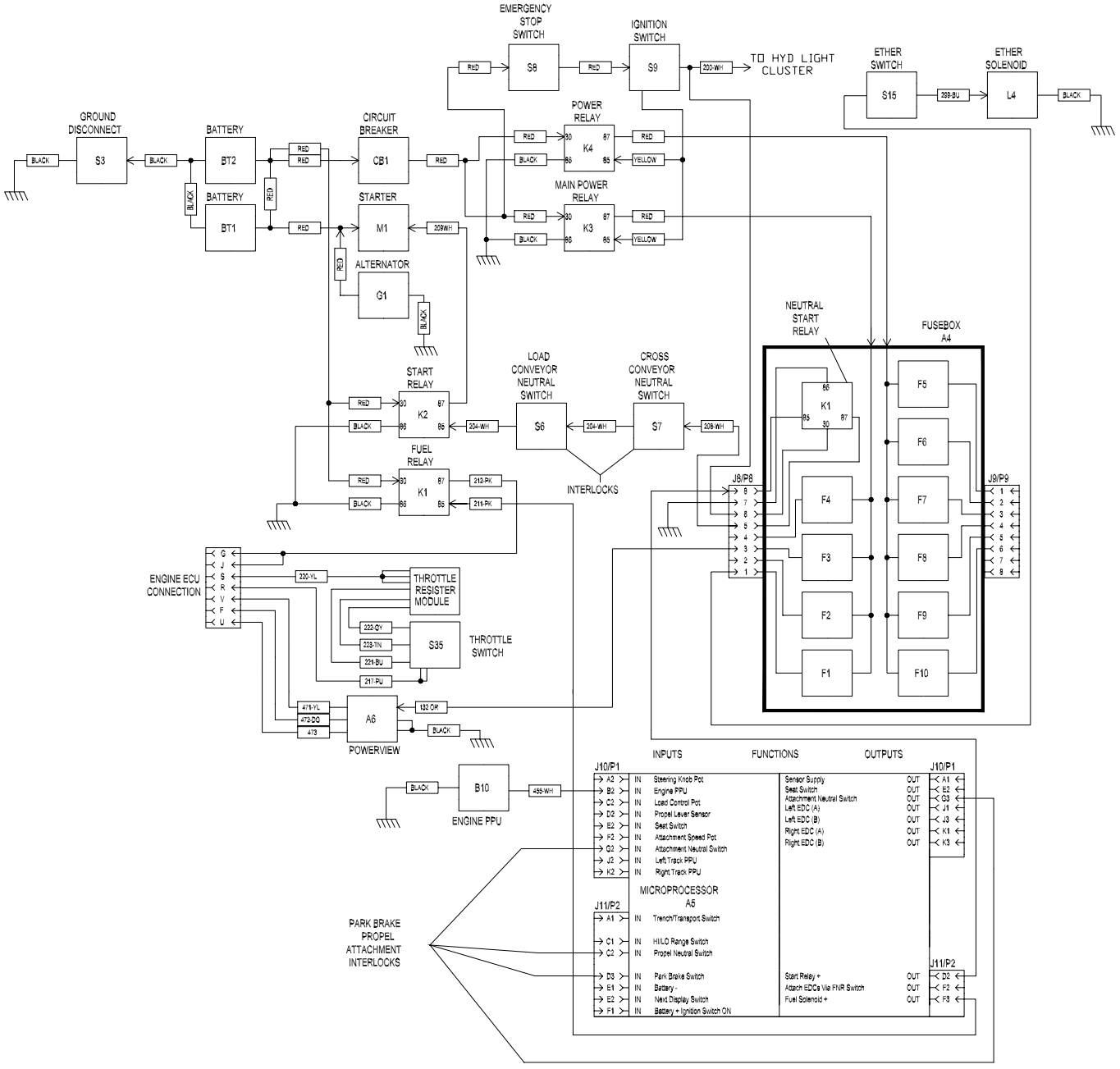
Once the engine is started, fuel travels through the engine's primary fuel/water separator filter FL12 and discharges fuel to a final stage filter located on the engine. The fuel then flows into the injector pump fuel gallery where it is delivered under high pressure through the fuel injector nozzles to the combustion chambers of the engine.

The operation of the electronically controlled, unit injected fuel system is controlled by the engine's ECU. The ECU regulates the fuel injection pressure, timing, and duration. The electronic unit injector is actuated by a signal from the ECU to energize and de-energize fuel injector's control solenoid.

During engine operation there is slight fuel leakage between injector nozzles and valve bodies. This is required for nozzle lubrication. The fuel leakage is returned to the fuel tank through the return line.

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IGNITION START/RUN CIRCUIT



Several control components wired to the microprocessor must be in their correct positions before the engine can start. When these interlocks are not in their correct positions, they are grounded. Whenever the microprocessor receives a ground signal from an interlock switch, it will not supply voltage to the start relay.

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To START engine the following controls must be set as follows:

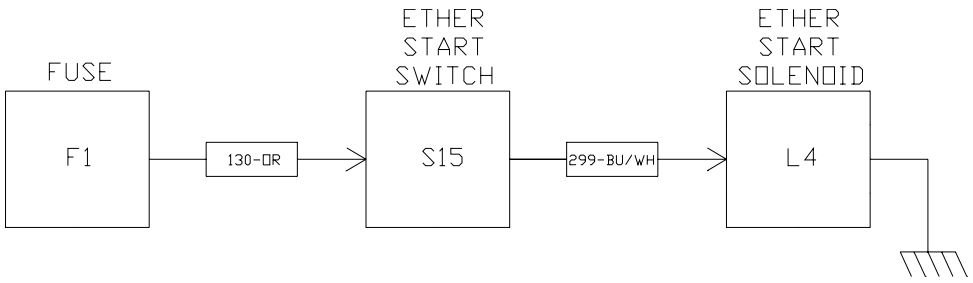
- Park Brake Switch - ON
- Attachment Control - NEUTRAL
- Propel Control - NEUTRAL
- Cross & Loading Conveyor Controls - NEUTRAL

Refer to “Machine Interlock Functions,” page 2-13 of the System Information Chapter for detailed information on the interlocks.

The microprocessor has two voltage outputs for engine START and RUN functions. When ignition switch is turned to START, one output supplies voltage to energize the neutral start relay A4K1. The conveyor switches located on the control valve assemblies are wired in series with the neutral start and start relays. When in NEUTRAL, the switches are closed, completing the circuit to the start relay K2. The start relay supplies power to energize the solenoid of starter motor.

The other output supplies voltage to energize the fuel (RUN) relay K1. The fuel relay switches power to the engine ECU. The ECU energizes the fuel injector’s electronic control and regulates the fuel injection pressure, timing, and duration.

Cold Start Circuit

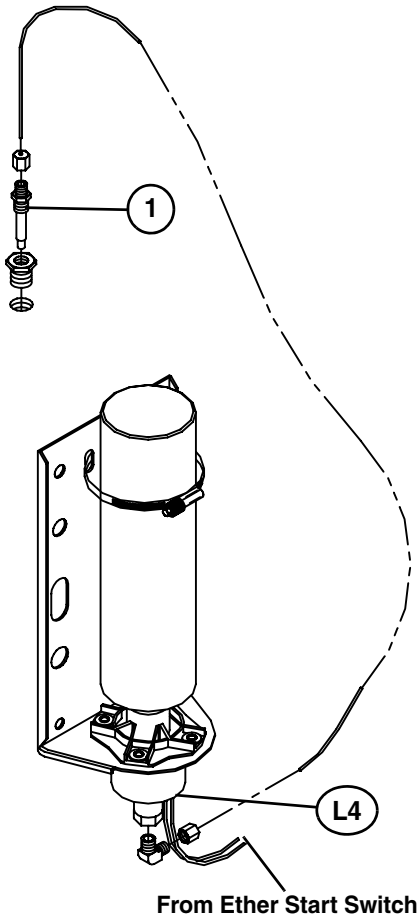


The cold start kit includes a control switch S15 located in the control console, a starter fluid cylinder filled with ether, a control solenoid L4, and associated tubing and hardware.

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The control switch receives power from fuse F1. When pressing switch S15, a voltage path is complete to the solenoid L4. The solenoid energizes, allowing starting fluid to flow to the atomizer **(1)**. The atomized fluid is sprayed into the engine's intake manifold to aid in cold weather starting.

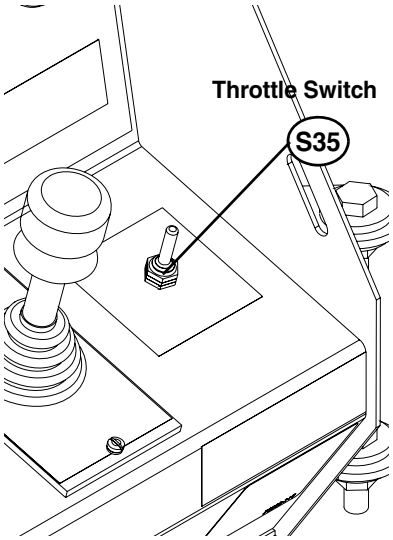


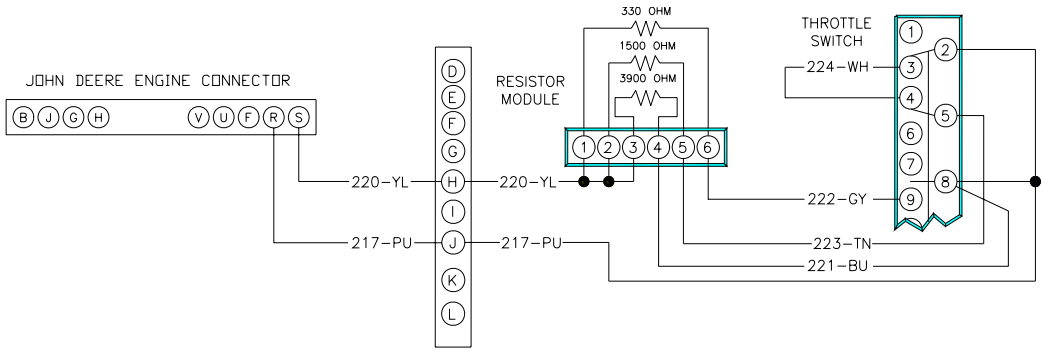
THROTTLE CIRCUIT

Engine RPM is controlled by the throttle switch S35 mounted on the dash.

The throttle circuit contains a resistor module. Different resistance signals to the ECU raise or lower engine RPM. Three different resistances will be sent to the ECU in the three different switch positions.

- Raise Throttle 3900 Ω (+- 50)
- Switch Centered 1083 Ω (+- 50)
- Lower Throttle 304 Ω(+- 50)



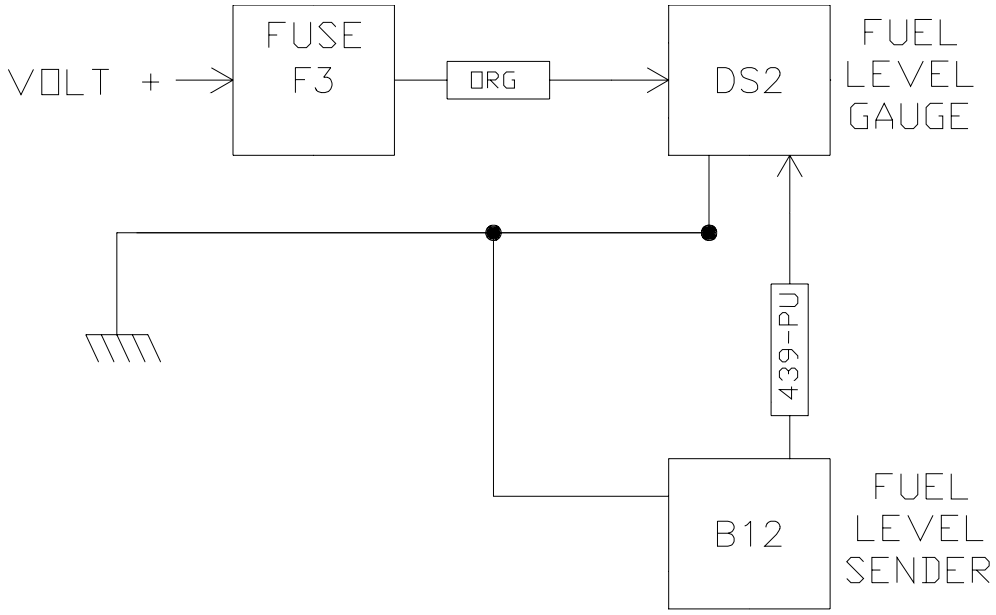


CHARGE CIRCUIT

The alternator G1 does not function until the engine has been started. Once the engine is started, the alternator supplies power to all electrical circuits and takes over the job that the battery performed. In addition, the alternator also provides a trickle charge to replenish the batteries after starting.

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GAUGE CIRCUIT



The fuel gauge receives voltage from a 5-amp fuse F3 and ground from the machine chassis.

The sender is grounded to the chassis. The sender supplies the gauge with an input signal based on level.

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Chapter 5: Engine Subsystem

Section B: Troubleshooting

OVERVIEW

Pretest Inspection

Before beginning any troubleshooting, review information in the General Information Chapter under “Troubleshooting Guidelines,” page 1-9.

If a malfunction occurs, do the following visual checks to inspect for obvious signs of failures before any testing is performed.

- Check for any obvious mechanical failures such as, broken linkages, cables, sprockets, chains, sheaves, pulleys, belts, and so on.
- Check for broken, missing, corroded, or loose wires and cable connections on the ground and power wires that supply electrical circuit components. Ensure batteries are fully charged and cables and ground straps are in good condition and connections are tight.
- Check for coolant, fuel, and engine oil leaks.

Correct any problems found during the inspection. Operate the machine to verify the malfunction is fixed.

Possible Malfunctions

The possible malfunctions listed below do not cover everything that could go wrong with the circuits and are only meant to give a technician a logical place to begin, based on how the machine is performing.

- Engine does not turn over. Refer to page 5B-7 and troubleshoot the ignition START/RUN circuit.
- Engine turns over but will not start. Refer to page 5B-6 and troubleshoot the fuel circuit.
- Engine runs but lacks power or smokes excessively. Refer to page 5B-4 and troubleshoot the air intake/exhaust system.
- The TEC 2000 microprocessor displays a fault indicating the engine PPU signal has been lost. Refer to page 5B-3 and troubleshoot engine speed circuit.

Continued on next page...

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- The TEC 2000 microprocessor displays a fault indicating the battery voltage is out of range. Refer to Power Distribution subsystem troubleshooting, page **3B-4** and test battery voltage. If OK, refer to page **5B-12** and troubleshoot charge circuit.
- Fuel Gauge not indicating correctly. Refer to page **5B-13** and troubleshoot gauge circuit.
- The engine shuts down during operation. Two components monitored by the engine ECU will cause the engine to shut down. Refer to page **5A-9**.

Test Equipment Needed

- Digital Multimeter

ENGINE

Engine Service

Consult the John Deere Engine Service Manual for all information on servicing or overhauling the engine.

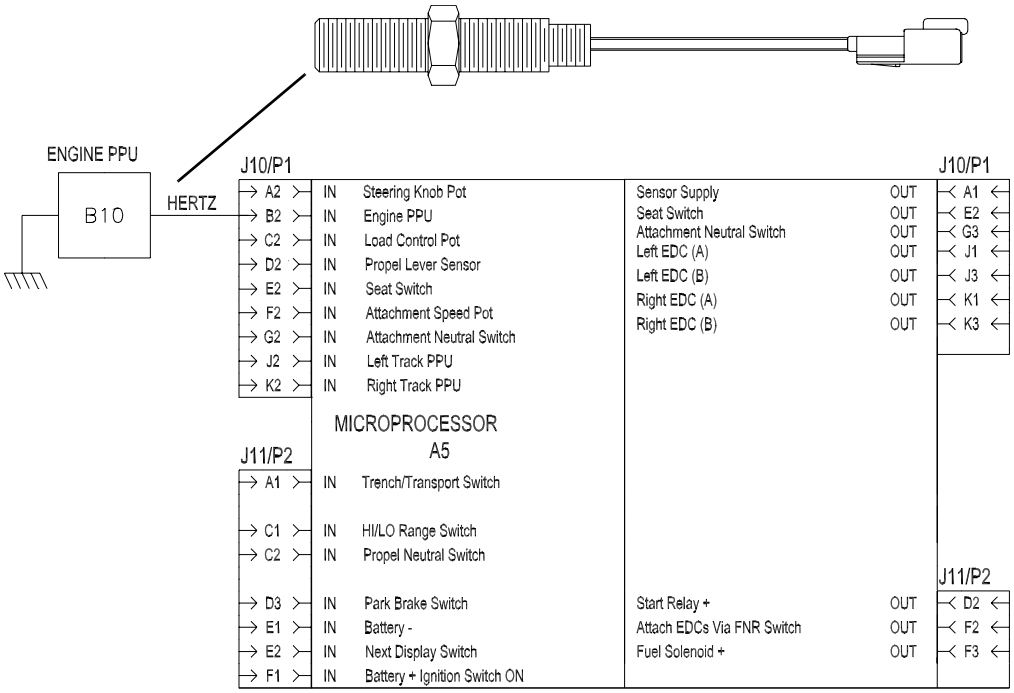
NOTE: The John Deere engine is covered under John Deere's warranty. You can void this warranty by attempting to repair the engine before the warranty has lapsed. If the warranty is still in effect, take engine to an authorized John Deere Service Facility.

Engine Maintenance

Refer to the T655III Trencher *Maintenance Manual* for information on engine maintenance schedules.

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ENGINE SPEED PPU CIRCUIT



The microprocessor fault code will be displayed on the TEC 2000 display screen anytime the engine PPU signal is lost. If this fault is displayed, test the engine speed PPU hertz.

Magnetic Pickup Sensor Hertz Test

Test PPU with engine running and engine speed set to full throttle.

1. Set multimeter to measure AC volts.
2. Pull plug apart far enough to make contact with meter probes. Place either probe to either terminal.
3. Push the Hz button on multimeter. the reading should be 5052.5 Hz ± 505 Hz.

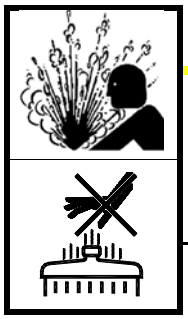
NOTE: On the Fluke 87, pushing the Hz button alternates between frequency (Hz), duty cycle (%), and OFF.

4. Check adjustment of sensor. For proper operation of the sensor, there should be a 0.030″ (0.76 mm) gap between the flywheel teeth and the tip of the sensor.
5. Back off lock nut.
6. Tighten by hand until sensor contacts flywheel.
7. Back off 1/2 turn.
8. Hold sensor to keep it from turning and tighten lock nut.
9. Check hertz, if reading is incorrect, replace PPU.

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COOLANT CIRCUIT

Coolant Level Check



WARNING: Hot fluid under pressure can scald.

Allow engine to cool before opening radiator cap.

NOTE: Never add pure antifreeze to a cooling system. Vermeer Mfg. Co. recommends using a 50/50 mixture. Never use high-silicate antifreeze or antifreeze that is higher than 60/40 mixture.

1. Inspect radiator for debris or damage that may be blocking air flow through fins.
2. Allow sufficient time for the engine and radiator to cool down. Remove fill cap, if low, fill to within 1/2″ (13 mm) of the bottom of the fill pipe with a 50/50 mixture of low-silicate (ethylene glycol) antifreeze and clean water.
3. Bring engine up to operating temperature with fill cap loose, then top off fluid if necessary. If high coolant temperatures persist, refer to John Deere service manual for troubleshooting.

AIR INTAKE/EXHAUST CIRCUIT

The air intake and exhaust circuit is crucial to the performance of the engine. If the engine performance or power output is poor, the engine will not produce the power needed to operate the subsystem circuits efficiently. If the engine lacks power, investigate the following components:

Continued on next page...

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Air Cleaner

If the air cleaner filter elements become clogged, the turbocharger will not receive enough clean filtered air.

1. View air restriction indicator. If the red indicator is at the bottom of the rectangle, replace primary filter element.
2. Inspect secondary or safety element. Replace if necessary.
3. Inspect precleaner. If material builds up on the screen, it can cause high engine air inlet temperature.
4. Visually inspect for any cracked, broken, or missing hoses, connectors, or clamps, and replace if found.

Turbocharger and Aftercooler

NOTE: The turbocharger is considered to be part of the John Deere engine and is covered under John Deere's warranty. You can void this warranty by attempting to remove or repair this system before the warranty has lapsed. If the warranty is still in effect, take the machine to an authorized John Deere Service Facility.

A number of turbocharger problems can effect engine efficiency. Possible indications include:

(1) Engine lacks power.

(2) Black exhaust smoke

(3) Excessive engine oil consumption

(4) Blue exhaust smoke

(5) Turbocharger is noisy.

(6) Cyclic siren sound from turbocharger

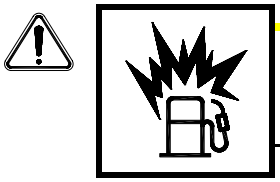
(7) Oil leak from compressor seal

(8) Oil leak from turbine seal

NOTE: Linkage on the turbo housing allows for an adjustment to change turbo efficiancy. This adjustment is to be made by Deere.

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FUEL CIRCUIT



WARNING: Fuel and fumes can explode and burn. Never refuel machine while smoking or with engine running. Fill fuel tank outdoors. Clean up spilled fuel. Do not allow any hot or burning material near the machine.

If the engine will not run or performance is not adequate, the fuel system should be investigated.

Engine Electronic features are controlled by an integral on-board computer. Current operating conditions are monitored and the Electronic Control Unit ECU tells the engine how to respond to the conditions and the demands of the operator. These conditions and operator demands determine the ECU's precise control of fuel injection.

If a problem in the electronic control of the fuel is suspected, or if you suspect the injector pump or fuel injectors are not delivering adequate fuel, first inspect the non-engine fuel system components, including the tanks, lines, filters, and strainers.

NOTE: The ECU, injector pump, and fuel injectors are considered to be part of the John Deere engine and are covered under John Deere's warranty. You can void this warranty by attempting to remove or repair this system before the warranty has lapsed. If the warranty is still in effect, take the machine to an authorized John Deere Service Facility.

Fuel Tanks, Lines, Filters, and Strainers

1. Visually inspect for any cracked, broken, or missing fuel lines, fittings, connectors, or clamps, and replace if found.

Water in Fuel

Water in the fuel can cause a failure. Condensation occurs as fuel is heated when passing through the fuel system and cools when returned to fuel tanks. If water in the fuel is suspected:

2. Drain fuel in the tanks. Inspect, clean, or replace the suction and return strainers in the bottom of fuel tanks.
3. Refer to the T655III *Maintenance Manual* and replace the engine fuel filters and drain any water from the fuel/water separator.

NOTE: Filling the fuel tanks at the end of each day of operation will drive out moist air and reduce condensation. Be sure not to fill the tanks to the top to allow for expansion during the next operation.

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IGNITION START/RUN CIRCUIT

Possible Malfunctions

- The ignition switch is turned to the START position and there is no electrical function at all, test the ignition ON circuit. Refer to page **3B-1** for troubleshooting procedures.
- The ignition ON circuit has power but the engine will not turn over, troubleshoot the start relay portion of the START/RUN circuit. Refer to the electrical troubleshooting on page **5B-8**.
- The engine turns over but will not start, troubleshoot the fuel relay portion of the START/RUN circuit. Refer to the electrical troubleshooting on page **5B-8**. If OK, refer to fuel circuit on previous page.

Engine Start Interlock Faults

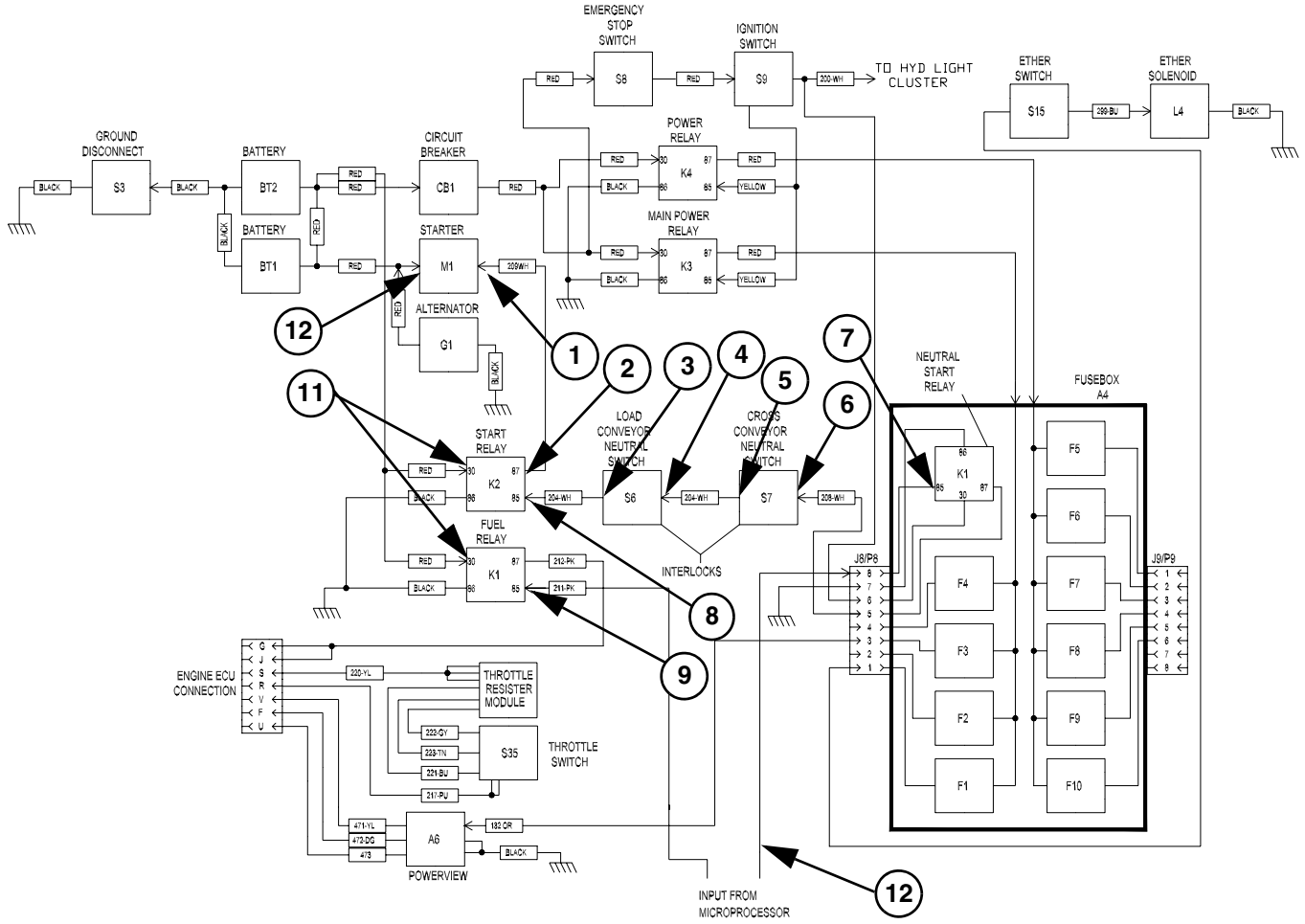
Problems with the engine start interlock circuits could effect the ignition START/RUN circuit. The TEC 2000 will detect a fault if the neutral start control switches are out of range. The TEC 2000 fault screen will display the fault. If so, refer to the appropriate subsystem troubleshooting procedures.

To START engine the following controls must be set as follows:

- Park Brake Switch - ON (ground drive SS)
- Attachment Control - NEUTRAL (attachment SS)
- Propel Control - NEUTRAL (ground drive SS)
- Cross & Loading Conveyor Controls - NEUTRAL (engine START/RUN)

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Electrical Troubleshooting



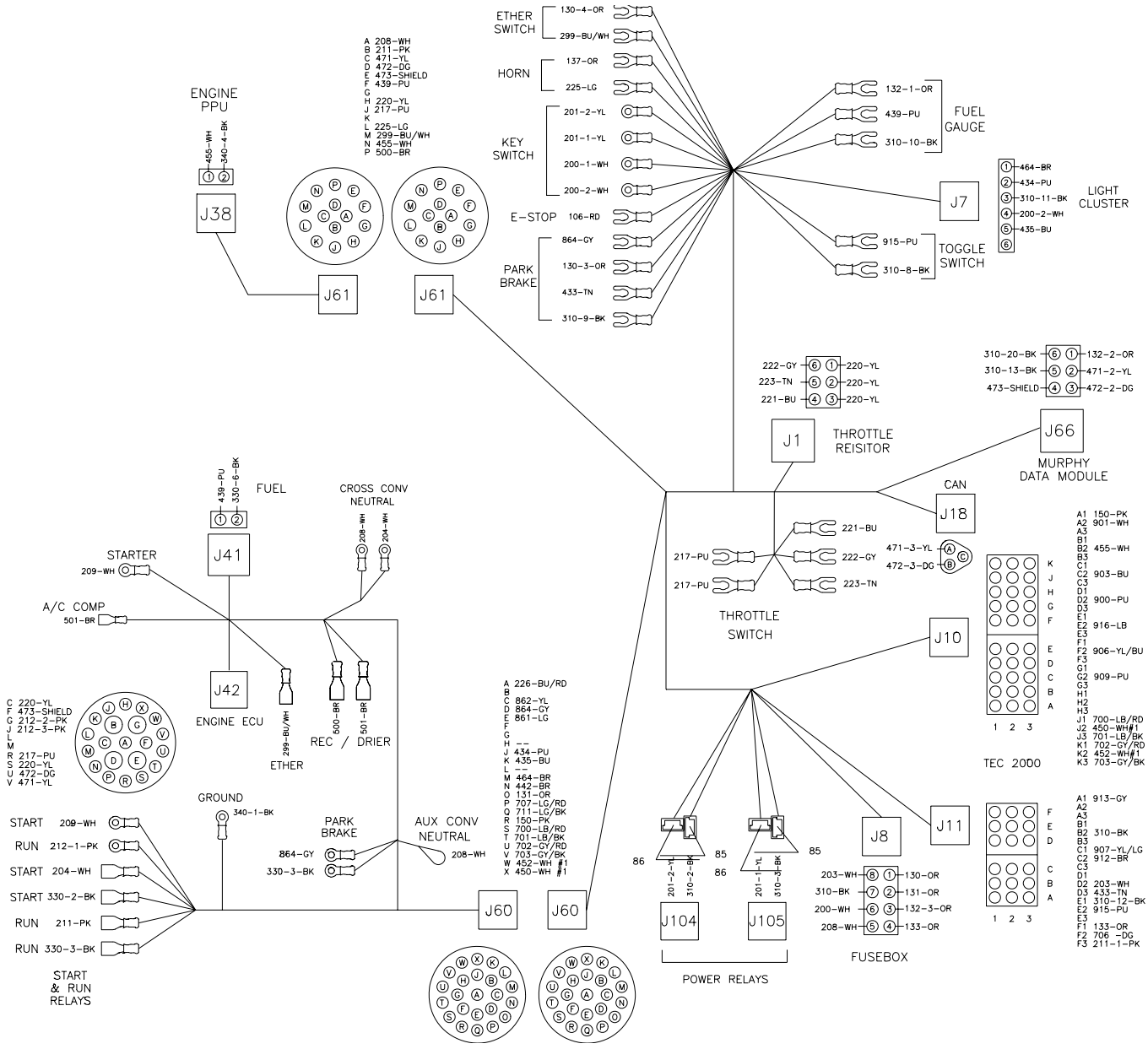
Circuit MAP The MAP above shows the interdependencies of the engine START/RUN circuits and components. The lines and arrows represent the inputs and outputs to and from each component.

Testing Sequence The testing sequence gives a troubleshooter a logical place to begin troubleshooting the electrical circuits. The sequence test points start at **(1)** end of the circuit and work back through the complete circuit. The procedures test for opens, shorts, or high resistance in the circuits.

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Component Pin/ Terminal Reference



The diagram above represents the wire harness connections of the ignition START/RUN circuits. Use the diagram for pin, terminal, wire, and plug reference when testing circuits and components.

For more detailed information on the TEC 2000 microprocessor pin designations and functions, refer to Chapter 2, System Information.

Continued on next page...

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Open Circuit Test

1. Test for an open in the circuit by testing for acceptable voltage on input and output pins/terminals of plugs and components at test points shown on circuit map on page 5B-8. Testing at these points, working through the circuit, will isolate the failed component by process of elimination. Continue through the steps until the open is found.

   Expected result: When the positive lead is placed before an open point, the meter will read full battery voltage with key respectively in start or run position. When the lead is placed beyond the open the meter will read no voltage, indicating that a complete circuit exists from the chassis ground to the point where voltage is last seen in the circuit.

2. Once the open is found, turn ignition switch OFF, unplug the wire harness at the suspected component and test for continuity. If the component is OK, test wires connecting the component for continuity. Replace faulty component or section of wire harness. If battery voltage is measured at points, continue next by measuring for voltage on ground side.

3. Normal voltage should measure 0.0–0.5 volts. If battery voltage is measured on ground side, a poor connection or broken wire/cable is indicated. Test wires connecting the component for continuity. Replace faulty component or section of wire harness.

High Resistance

Measurements taken from a multimeter can be used to troubleshoot for unwanted resistance. Use meter to test for lower than normal battery voltage (voltage drop) while moving to accessible points in the circuit wiring. Replace section of failed wire harness. Refer to the circuit MAP on page 5B-8.

Short Circuit Test

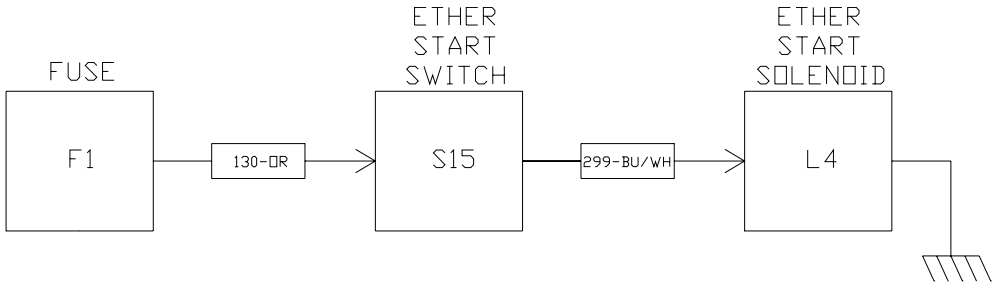
1. Test for a short in the circuit. When testing the circuit for a short, turn ignition switch OFF and set multimeter to measure resistance (ohms) and work through the circuit. If the meter measures resistance through the complete circuit, it may be an intermittent problem causing the short. In that case, repeat the procedure and move wiring harness or tap on components while watching for a sudden drop in resistance Ω

   Expected result: If the voltage side of the circuit is shorted to ground, the meter will read 0.0 Ω This indicates there is no resistance between check points (a dead short). Work through the circuit until the short is located. When the short is removed the meter will return to a resistance reading.

2. Repair or replace faulty component or section of wire harness. Check circuit for function.

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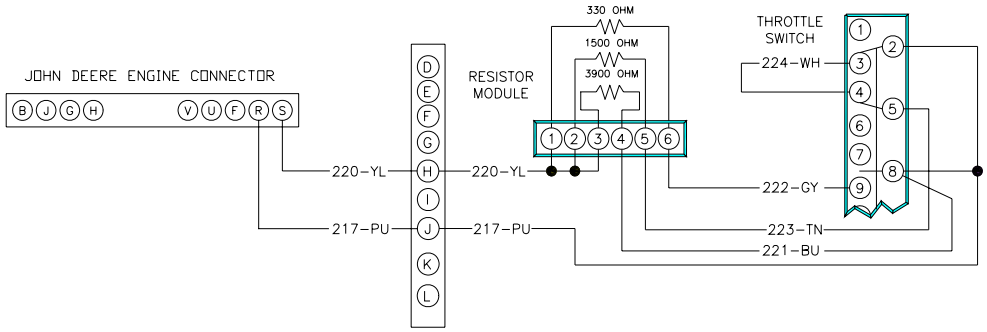
Cold Start Circuit



If the cold start function is utilized in cold weather and the engine will not start.

1. Ensure ether canister is not empty. If OK, continue.
2. Ensure fuel system and fuel circuits are functioning properly. Refer to page 5B-6 for information on fuel system components. Refer to page 5B-7 for information on fuel relay circuit. If OK, continue.
3. Troubleshoot cold start electrical circuit. Test circuit for an open, short, high resistance or faulty ground connection. See previous page. Replace any faulty component or section of wire harness.

THROTTLE CIRCUIT



If the engine RPM does not respond when the throttle lever is moved, investigate the electrical circuit.

NOTE: The resistor module must be in place and working or the throttle circuit will not function.

1. Test circuit for an open, short, high resistance or faulty ground connection. See previous page. Replace any faulty component or section of wire harness.
2. If circuit tests OK, refer to John Deere engine service manual for information on the electronic control unit ECU troubleshooting and repair.

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CHARGE CIRCUIT

If the batteries fail to stay charged, the charge circuit should be investigated. Begin troubleshooting as follows:

1. Ensure all connections and wires around the batteries and alternator are tight and in good condition with no corrosion or rotted insulation. Identify both (+) and (-) battery posts and visually inspect for corrosion around the battery cable terminals.
2. Refer to page 3B-4 and test batteries. If OK, continue.

The condition of the charge in the batteries at regular inspections will indicate if the charging system is operating properly. A problem exists when the batteries are constantly in a condition of low charge. The LCD digital display unit can be utilized to view the system voltage. Refer to page 5A-6 for information on display unit.

Alternator G1

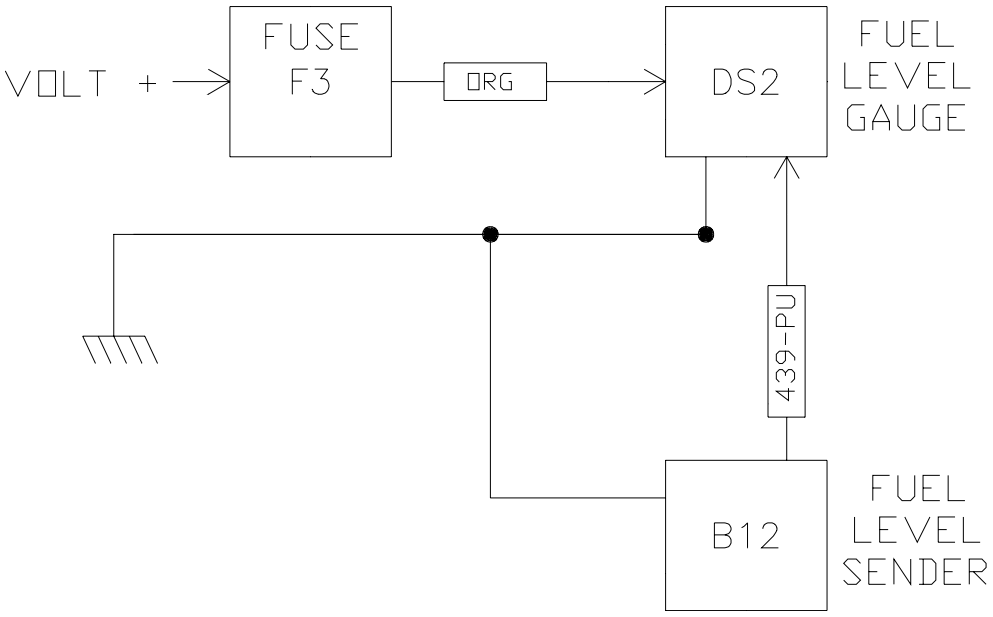
Locate alternator's B+ terminal. Inspect wire at this terminal to ensure it is clean and connection is tight.

1. Check to ensure alternator belt is tight.
2. Ensure batteries are at full state of charge.
3. Start engine and allow it to warm up for a few minutes.
4. Increase engine RPM to full throttle.
5. With multimeter set to measure DC voltage, connect positive lead to the battery + stud on the alternator and negative lead on the bracket of the alternator.

   Expected result: The alternator output voltage should be at least half a volt (.5-volt) above the battery voltage. If not, replace alternator.

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FUEL GAUGE CIRCUIT



Fuel Gauge

If the fuel gauge fails to indicate correctly, first check the wiring and terminals connecting the gauge to the circuit for corrosion, broken or damaged wires.

Voltage Test

1. Gain access to the terminals on the rear of gauge.
2. Turn ignition switch to the ON position. Set multimeter to measure DC voltage. Place red probe to battery + input terminal of gauge. Place black probe to ground terminal.

   Expected result: A reading of approximately 12 volts indicates gauge is receiving acceptable voltage from fuse F3.

Open Sensor Test

3. With ignition ON, remove sensor lead from back of gauge.

   Expected result: The gauge should read minimum scale. If not, replace gauge.

Sensor Ground Test

4. Install sender lead back to gauge.
5. Short signal wire from the gauge to ground.
6. The gauge should read full scale. If so, the gauge is OK. Test sender unit.

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7. With ignition switch in the OFF position, disconnect wire harness from sender. Set multimeter to measure resistance (ohms).

   Expected result: The ohms reading will be proportional to the level of fuel. If not, replace sender.

Chapter 5: Engine Subsystem

Section C: Repair

SUMMARY

The Engine subsystem repair consists of standard maintenance, such as:

- replacing engine oil and filter
- replacing fuel tank breather filter
- replacing fuel tank suction screen
- replacing air cleaner elements
- replacing radiator/engine coolant
- replacing engine belts

Refer to the T655III Trencher *Maintenance Manual* for information.

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Chapter 6—Implement Subsystem

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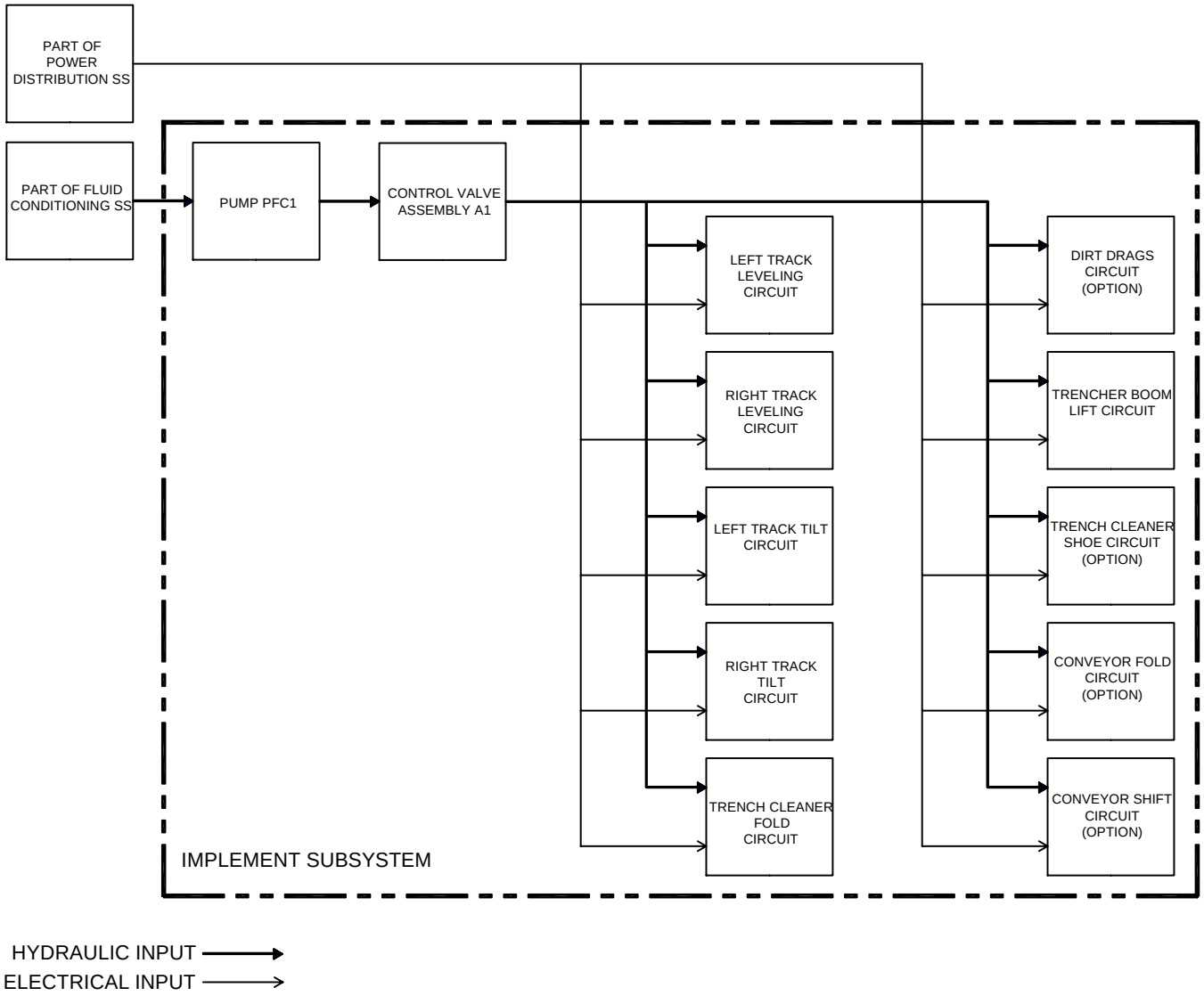
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Chapter 6: Implement Subsystem

Section A: Theory

OVERVIEW

MAP



Lines and arrows on the MAP illustrate the interdependencies of the subsystems. The power distribution and fluid conditioning subsystems supply the electrical and hydraulic input necessary for operation.

Continued on next page...

The Implement subsystem consists of the circuits and components necessary for track tilting and leveling, trencher boom lifting, trench cleaner fold and trench cleaner shoe functions, conveyor fold and shift functions, and dirt drag functions. All implement circuits utilize a common hydraulic pump and control valve assembly as well as the fluid conditioning subsystem components. All implement circuits utilize the power distribution subsystem components but only two fuses F5 & F6 protect all of the circuits.

Circuits/Components

The following circuits and components are used in the Implement subsystem.

Components Shared by all Circuits:

Power Distribution Components
Fluid Conditioning Components
Hydraulic Pump PFC1
Control Valve Assembly A1

Left Track Tilt Circuit:

Left Tilt Cylinder CY5
Left Manual Tilt Control Switch S31

Right Track Tilt Circuit:

Right Tilt Cylinder CY6
Right Manual Tilt Control Switch S32

Left Track Machine Level Circuit:

Left Machine Level Cylinders CY1 & CY2
Left Machine Level Control Switch S29
Auto Level Mercury Switch S16
Auto Level Control Switch S28

Right Track Machine Level Circuit:

Right Machine Level Cylinders CY3 & CY4
Right Machine Level Control Switch S30
Auto Level Mercury Switch S16
Auto Level Control Switch S28

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Trencher Boom Lift Circuit:

Boom Lift Cylinders CY13 & CY14
Boom Lift Lock Valve LCK1
Boom Lift Control Switch S21
Pressure Reducing Valve PRD1 (Auto Down Pressure Option)
Pressure Reducing Valve PRD2 (Auto Down Pressure Option)
Auto Down Pressure Control Switch S27 (Option)

Trench Cleaner Fold Circuit:

Trench Cleaner Fold Cylinder CY7
Trench Cleaner Fold Control Switch S24

Trench Cleaner Shoe Circuit (Optional):

Trench Cleaner Shoe Cylinder CY8
Trench Cleaner Shoe Lock Valve LCK3
Trench Cleaner Shoe Control Switch S22

Conveyor Fold Circuit (Optional):

Conveyor Fold Cylinders CY9 & CY10
Conveyor Fold Control Switch S26

Conveyor Shift Circuit (Optional):

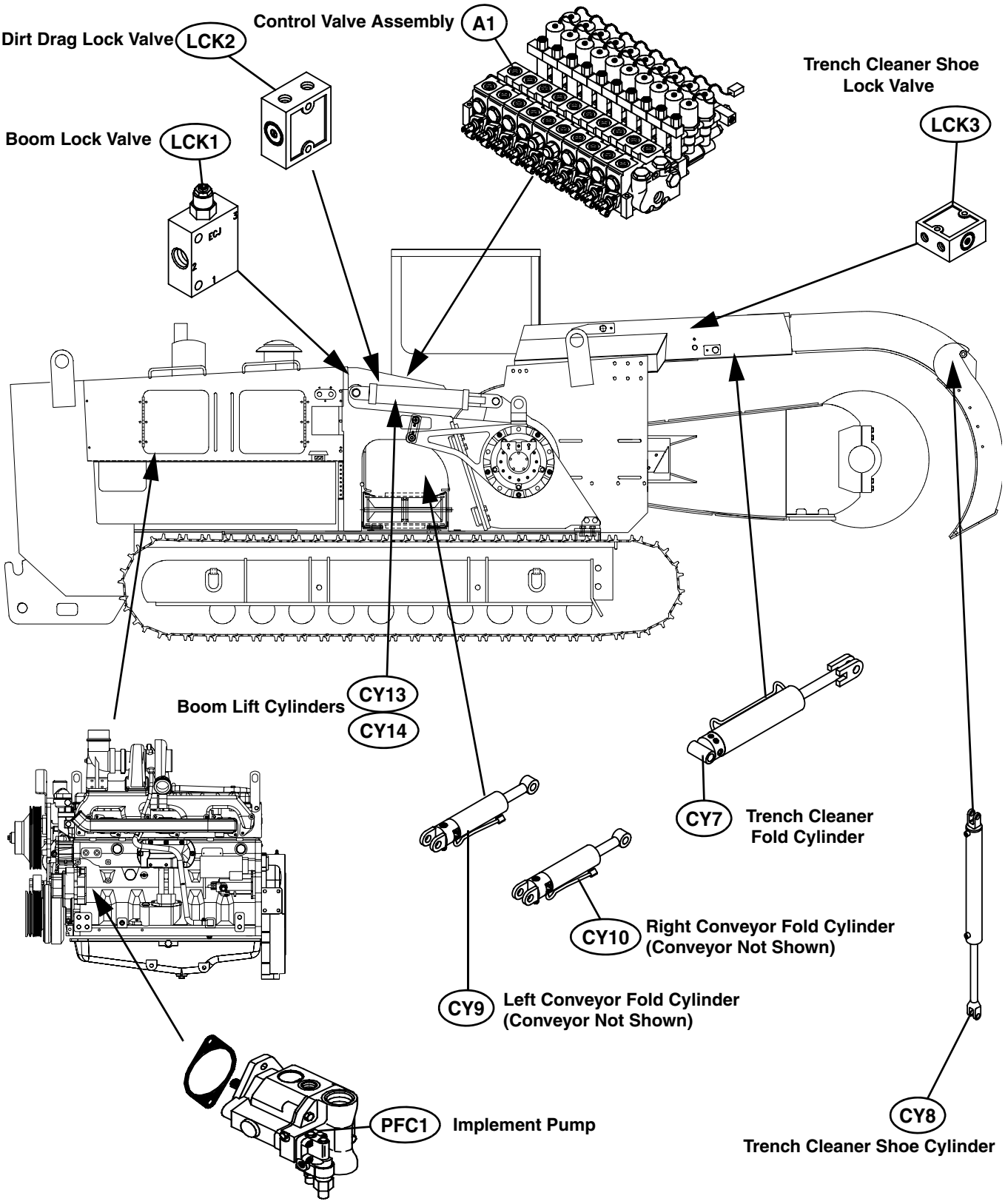
Conveyor Shift Motor B1
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Dirt Drags Circuit (Optional):

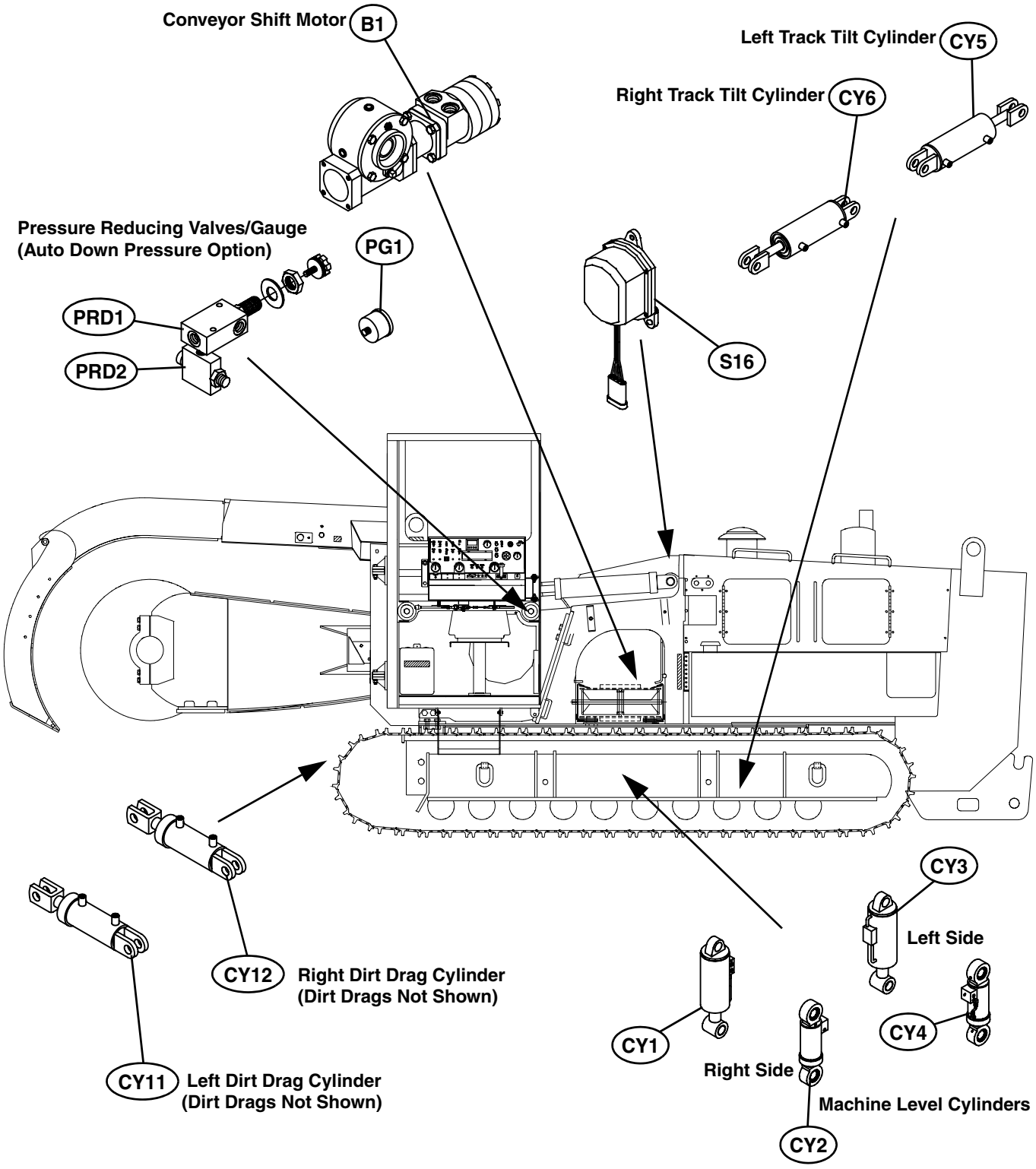
Dirt Drag Cylinders CY11 & CY12
Dirt Drags Lock Valve LCK2
Dirt Drags Control Switch S25

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Component Locations



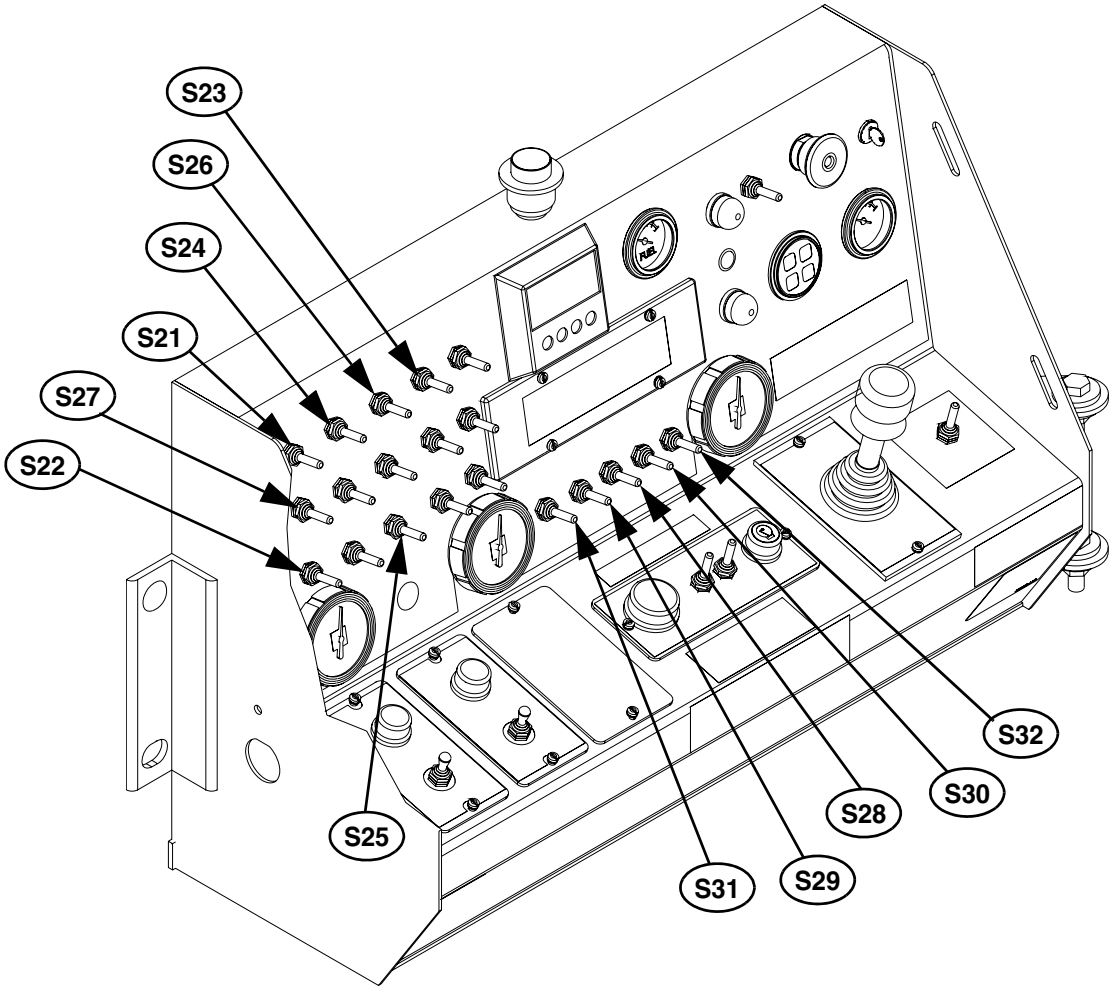
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Control Panel Component Locations



S21 - Boom Lift Control Switch

S22 - Trench Cleaner Shoe Control Switch

S23 - Conveyor Shift Control Switch

S24 - Trench Cleaner Fold Control Switch

S25 - Dirt Drags Control Switch

S26 - Conveyor Fold Control Switch

S27 - Auto Down Pressure Control Switch (Optional)

S28 - Auto Level Control Switch

S29 - Left Machine Level Control Switch

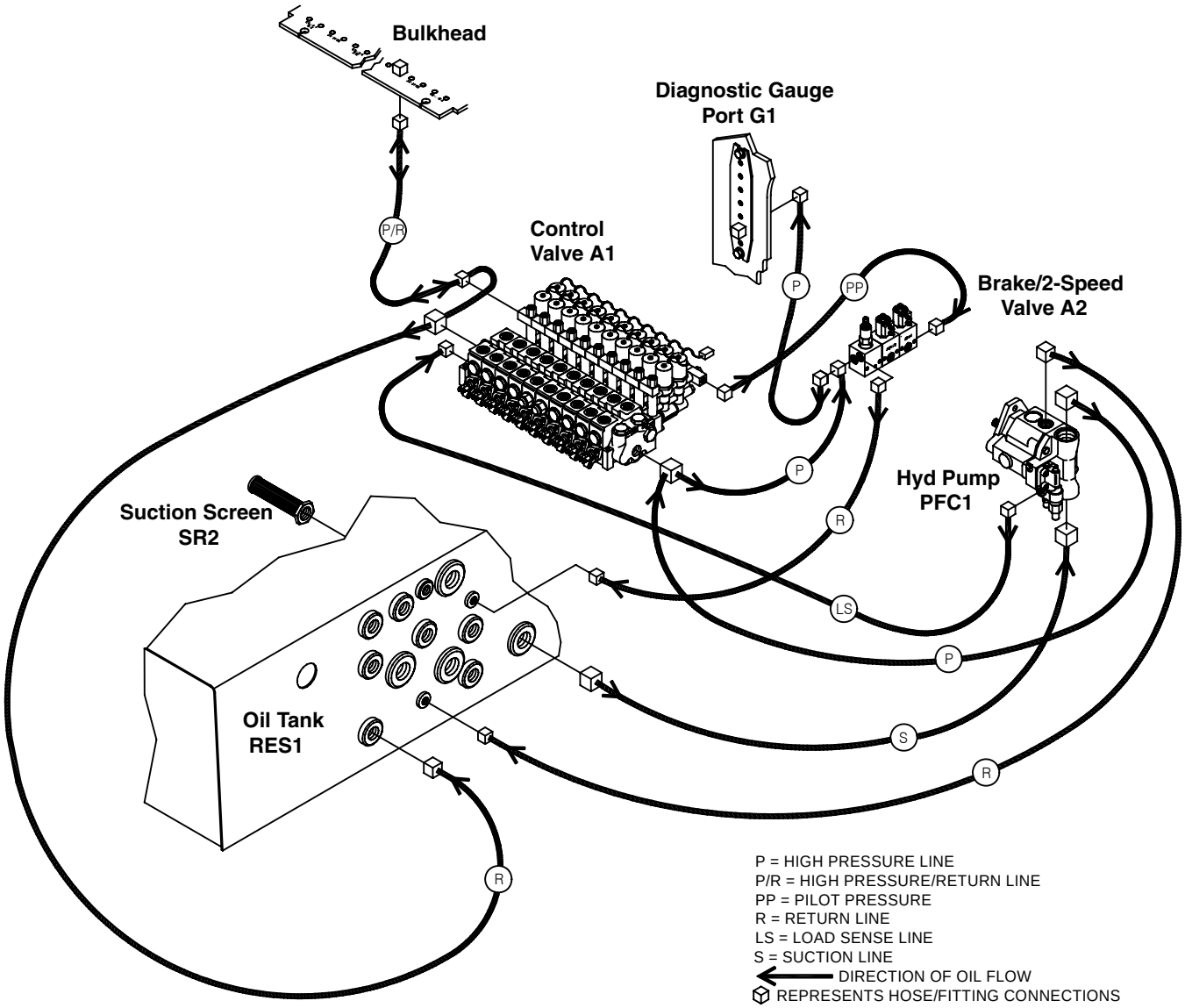
S30 - Right Machine Level Control Switch

S31 - Left Track Tilt Control Switch

S32 - Right Track Tilt Control Switch

Hydraulic Hose Connections - Supply and Return

Note: Orientation of components does not reflect actual machine configuration.

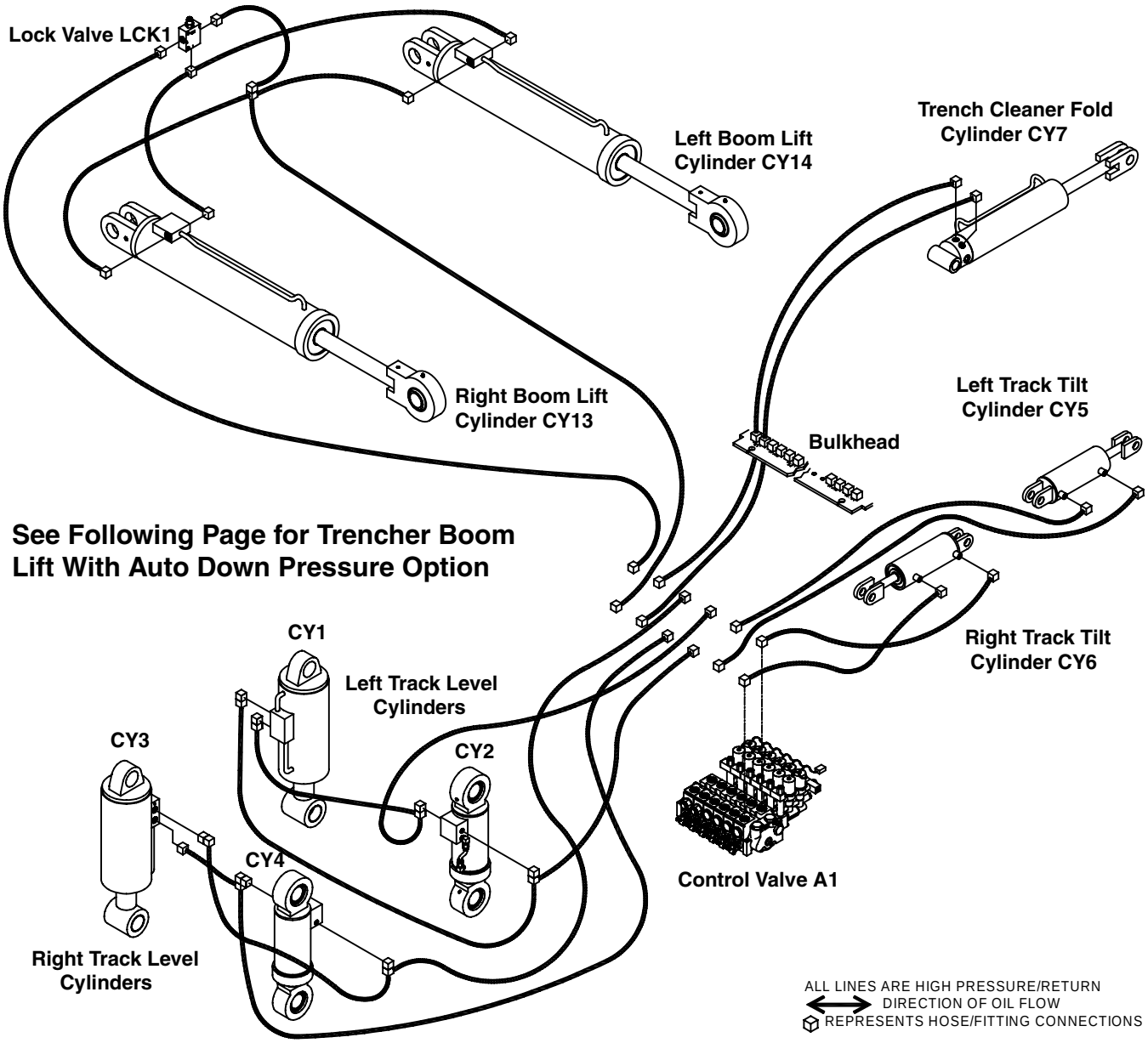


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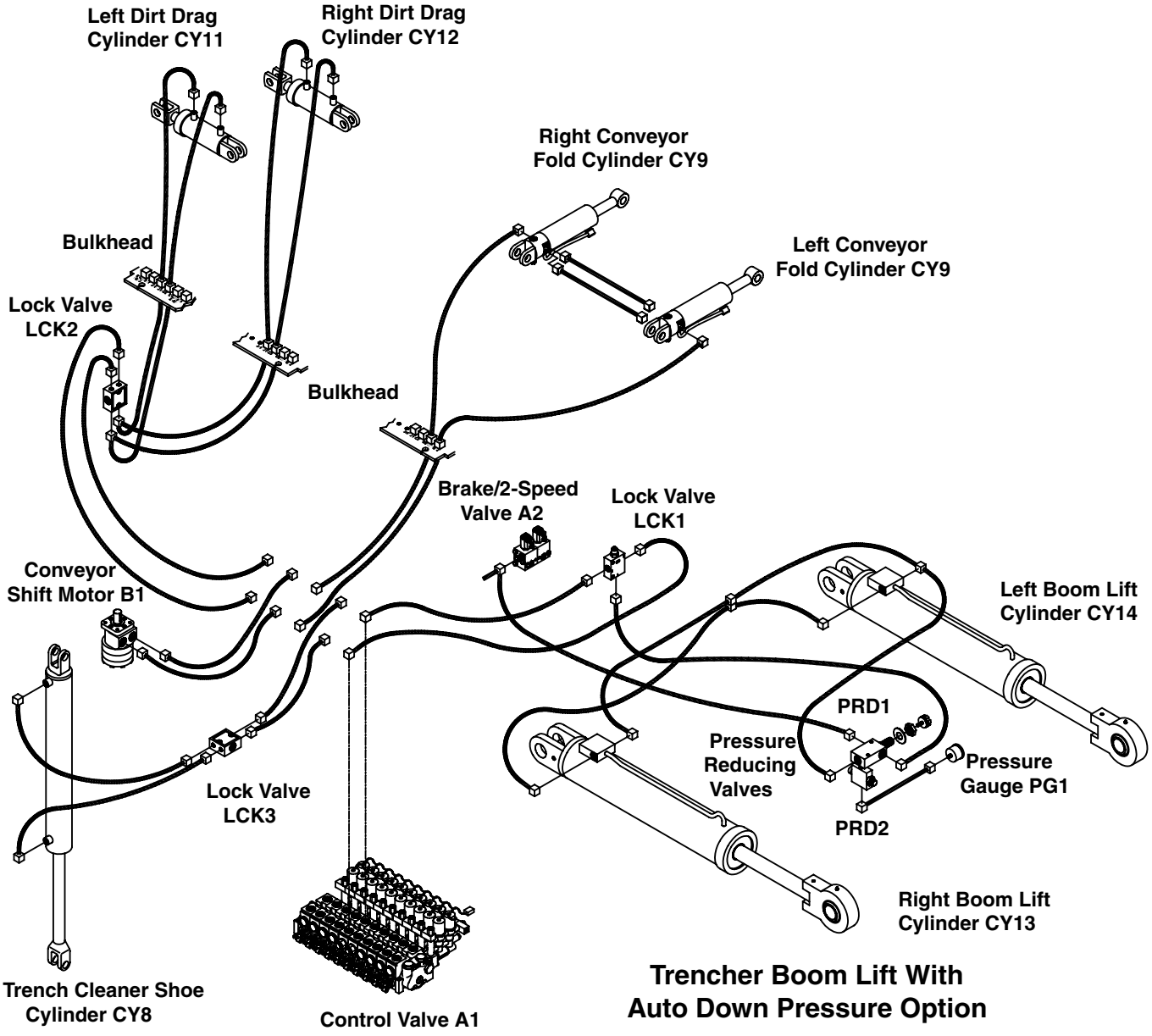
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Hydraulic Hose Connections - Standard 6-Bank Valve Configuration

Note: Orientation of components does not reflect actual machine configuration.



Hydraulic Hose Connections - (Optional) 10-Bank Valve Configuration

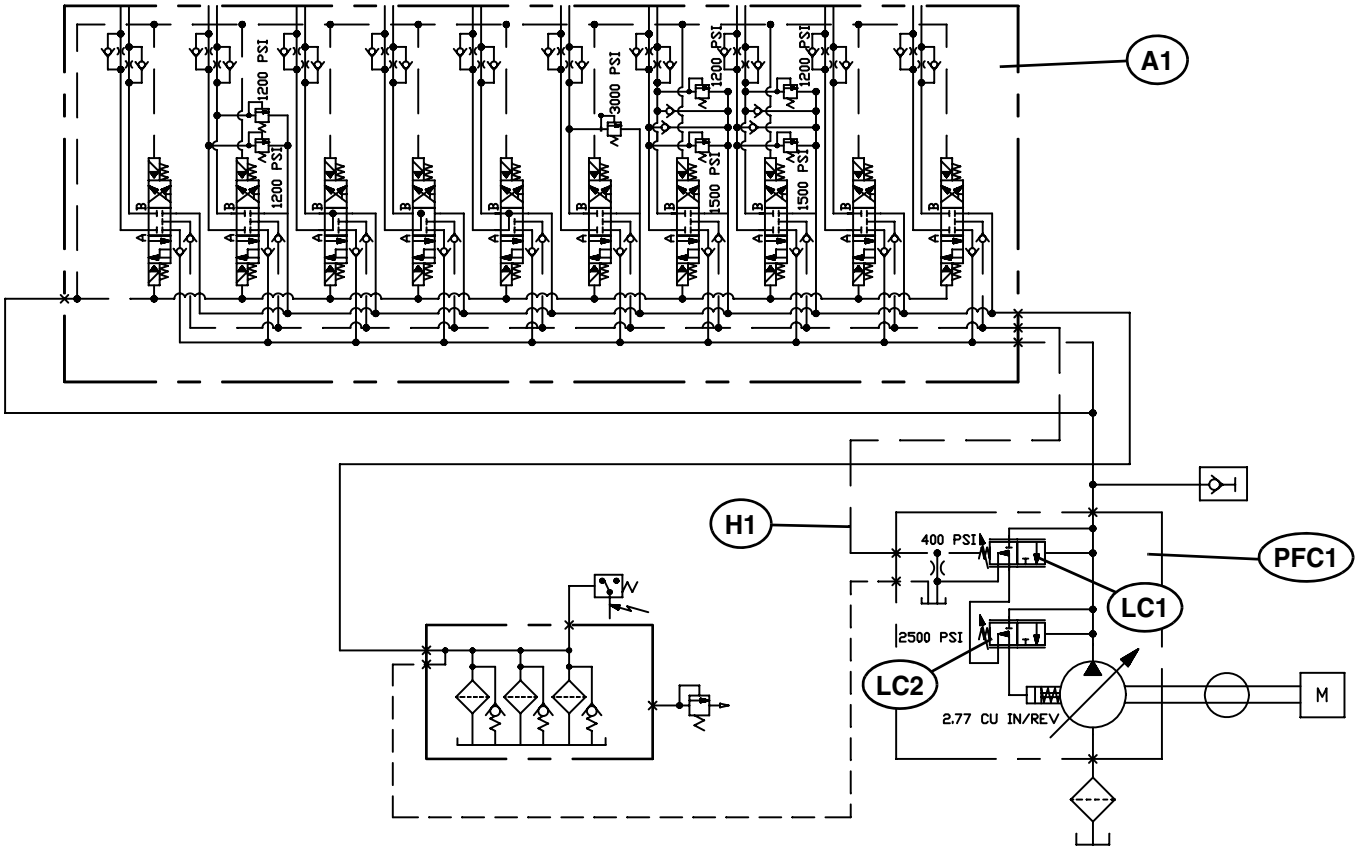


Trencher Boom Lift With Auto Down Pressure Option

ALL LINES ARE HIGH PRESSURE/RETURN
↔ DIRECTION OF OIL FLOW
REPRESENTS HOSE/FITTING CONNECTIONS

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PRESSURE-FLOW STANDBY CIRCUIT



For information on fluid conditioning components, refer to Chapter 4 (Fluid Conditioning subsystem).

The pump is considered a common component to all the Implement subsystem circuits because it supplies the hydraulic oil flow and pressure required for operation.

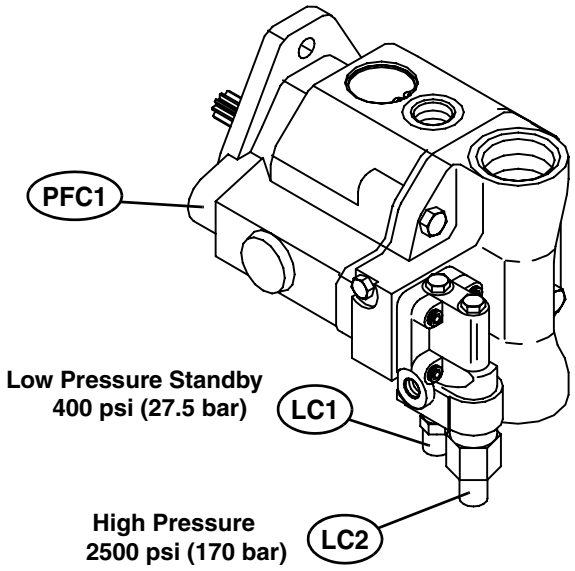
Hydraulic Pressure-Flow Compensated Pump PFC1

When the hydraulic system is non-actuated, the pressure-flow compensated piston pump PFC1 will remain in the low pressure standby mode at only 400 psi (27.5 bar). The stand-by pressure is maintained to make up for leakage in the system.

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When a hydraulic function is actuated, the piston pump senses the demand for flow and adjusts the pump displacement to increase the flow required at only the pressure required to operate the circuit, plus the 400 psi (27.5 bar) to operate the low pressure compensator LC1.

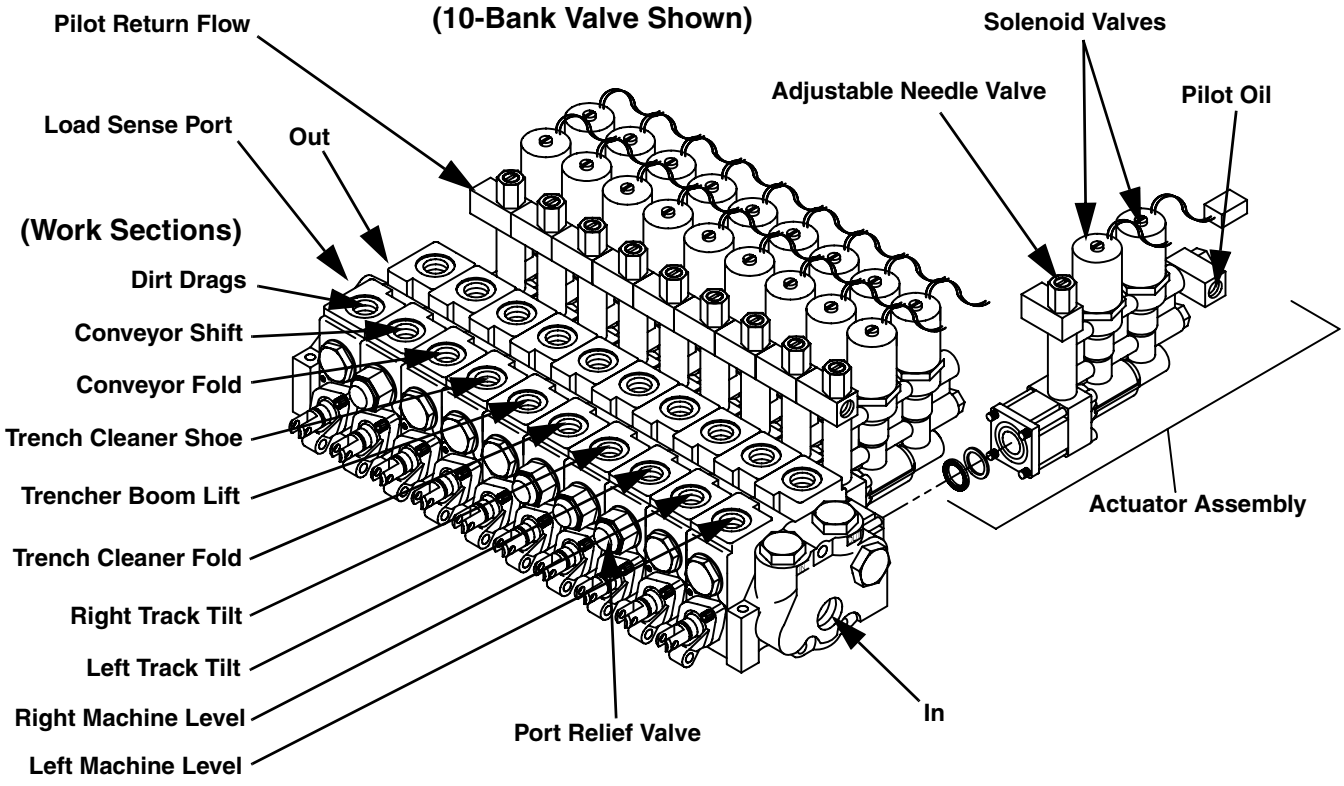


The pump will strive to maintain the flow required, under all working conditions of the system. A load-sensing line H1 is connected from the load-sensing control valve assembly A1 to the pump to feed all the circuit requirements to the pump compensator.

The pump will respond to the highest pressure of all the circuits and provide the total flow required to operate multiple circuits. If the load in the system produces a hydraulic pressure that is equal to the high pressure setting of the high pressure compensator LC2, which is set at 2500 psi (170 bar), the pump will go into high pressure standby mode and destroke until the load is overcome or the control valve is returned to NEUTRAL.

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Control Valve Assembly A1



The control valve assembly is considered a common component to all the Implement subsystem circuits because it distributes the hydraulic oil flow and pressure to each circuit as required for operation.

The control valve assembly A1 consists of 6–10 solenoid-controlled, pilot-operated actuators, depending on the optional features installed. The solenoid control allows the circuits to be operated remotely from a control panel. Each actuator assembly is responsible for the control of a specific circuit.

Each actuator contains two normally-closed solenoid-operated valves and a pilot-operated piston mounted directly to the control valve spool. When a solenoid is energized, the solenoid valve opens, pilot pressure is applied to one side of the piston, causing the spool to shift from its NEUTRAL position. When both solenoids are de-energized, both sides of the piston are open to exhaust and the spool is spring-returned to NEUTRAL.

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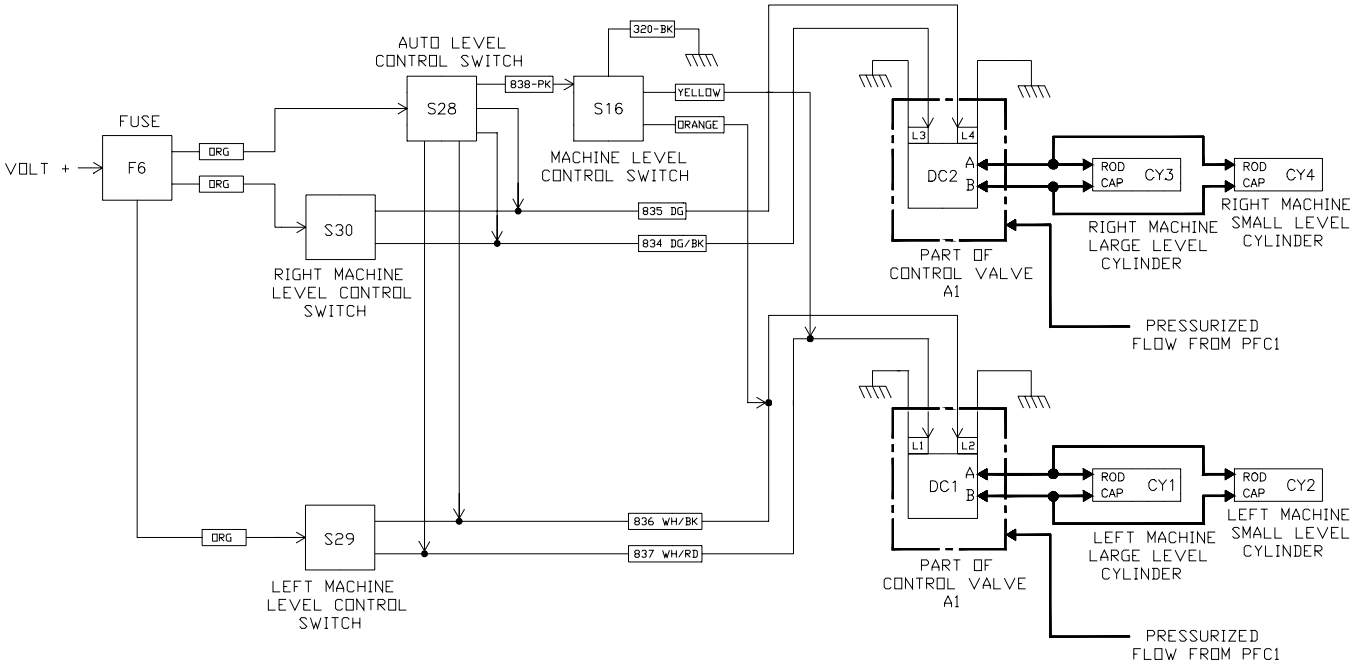
The actuator assemblies contain an externally adjustable needle valve that adjusts the exhaust pilot flow to control the spool's rate of travel. Pilot oil applied to the control pistons is supplied by the 2-speed brake valve assembly.

Port reliefs are installed in some of the valve sections to control circuit pressure while the machine is trenching. Those valve sections and pressure settings are as follows:

- both sides of the two machine level valve sections - one 1200 psi (83 bar) & one 1500 psi (103 bar)
- one side of trench cleaner fold valve section - one 3000 psi (207 bar)
- both sides of the optional conveyor shift valve section - two 1200 psi (83 bar)

Refer to the following circuit theory for more operating information on the port relief valves.

LEFT TRACK LEVEL CIRCUIT



Operation

The control valve assembly A1 receives pressurized oil flow from piston pump PFC1. The left track level control switch S29 receives power from a 5-amp fuse F6.

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Cylinder - Extend (Raise)

When the left level control switch S29 is pushed UP, a voltage path is complete to energize solenoid L2 of directional control valve section A1DC1. The valve spool will shift, directing oil through the B port of valve section DC1 to base of cylinders CY1 & CY2.

Cylinder - Retract (Lower)

When the switch is pushed DOWN, a voltage path is complete to energize solenoid L1 of directional control valve section A1DC1. The valve spool will shift, directing oil through the A port of the valve section DC1 to rod end of cylinders CY1 & CY2.

Counterbalance Valves

The track level cylinders incorporate counterbalance valves (not shown), designed to counteract the weight of the machine when it is lowered. The valves control the rate of decent and work as a lock valve when the control is non-actuated to keep cylinders from seeping down. The valves also ensure the cylinders will not move if a hose or fitting fails.

Auto Level

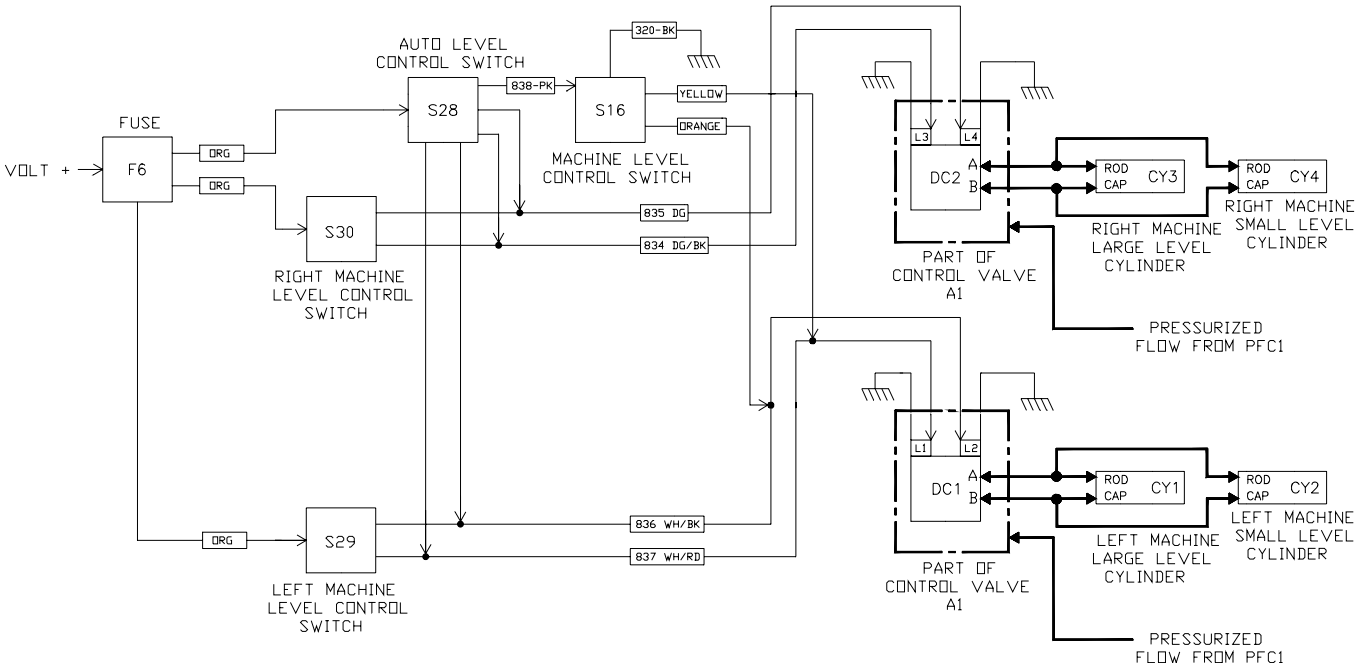
The auto level function is designed to automatically keep the machine level during operation. The auto level control switch S28 receives power from a 10-amp fuse F6. When the auto level switch is turned ON, switch pushed UP, a voltage path is complete to the auto level mercury-controlled switch S16.

If the machine becomes unlevel during operation, the mercury switch will energize the appropriate left or right track level control valve solenoids to actuate the cylinders. The tracks will adjust as necessary to level machine up to 10° in either direction.

NOTE: Tracks may require manual tilting to keep grousers flat on the ground.

When the auto level switch is turned OFF, switch is pushed DOWN, a voltage path is interrupted to the auto level mercury-controlled switch S16. The machine level will have to be controlled using the manual left and right control switches S29 & S30.

RIGHT TRACK LEVEL CIRCUIT



Operation

The control valve assembly A1 receives pressurized oil flow from piston pump PFC1. The right track level control switch S30 receives power from a 5-amp fuse F6.

Cylinder - Extend (Raise)

When the right level control switch S30 is pushed UP, a voltage path is complete to energize solenoid L4 of directional control valve section A1DC2. The valve spool will shift, directing oil through the B port of valve section DC2 to cap (base) end of cylinders CY3 & CY4.

Cylinder - Retract (Lower)

When the switch is pushed DOWN, a voltage path is complete to energize solenoid L3 of directional control valve section A1DC2. The valve spool will shift, directing oil through the A port of the valve section DC2 to rod end of cylinders CY3 & CY4.

Counterbalance Valves

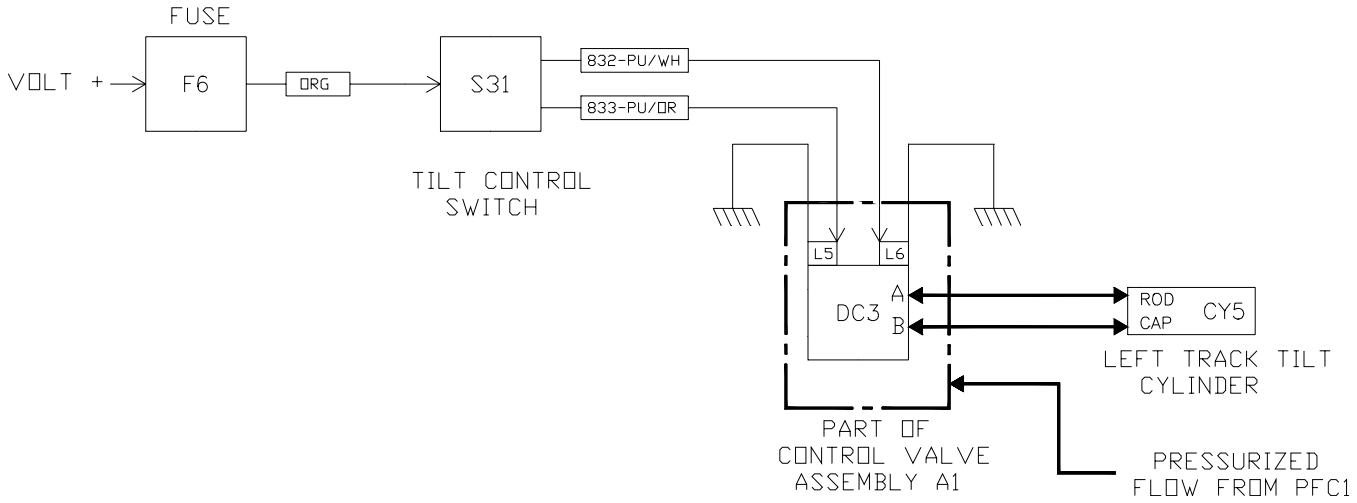
The track level cylinders incorporate counterbalance valves (not shown), designed to counteract the weight of the machine when it is lowered. The valves control the rate of decent and work as a lock valve when the control is non-actuated to keep cylinders from seeping down. The valves also ensure the cylinders will not move if a hose or fitting fails.

Auto Level

Refer to Left Track Level Circuit for information.

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LEFT TRACK TILT CIRCUIT



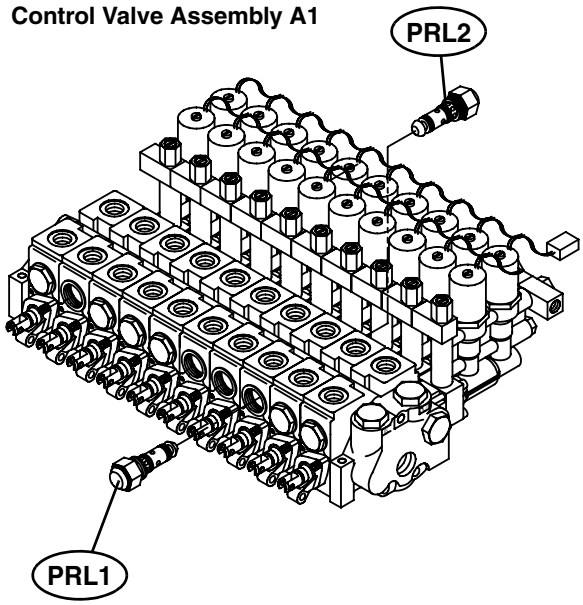
Operation

The control valve assembly A1 receives pressurized oil flow from piston pump PFC1. The left manual tilt control switch S31 receives power from a 5-amp fuse F6.

Port Relief Valves

The left track tilt circuit utilizes relief valves installed in the valve section to control circuit pressure during trenching. Valve PRL1 limits circuit pressure to 1200 psi (83 bar) when cylinders are extending. Valve PRL2 limits circuit pressure to 1500 psi (103 bar) when the cylinders are retracting.

Control Valve Assembly A1



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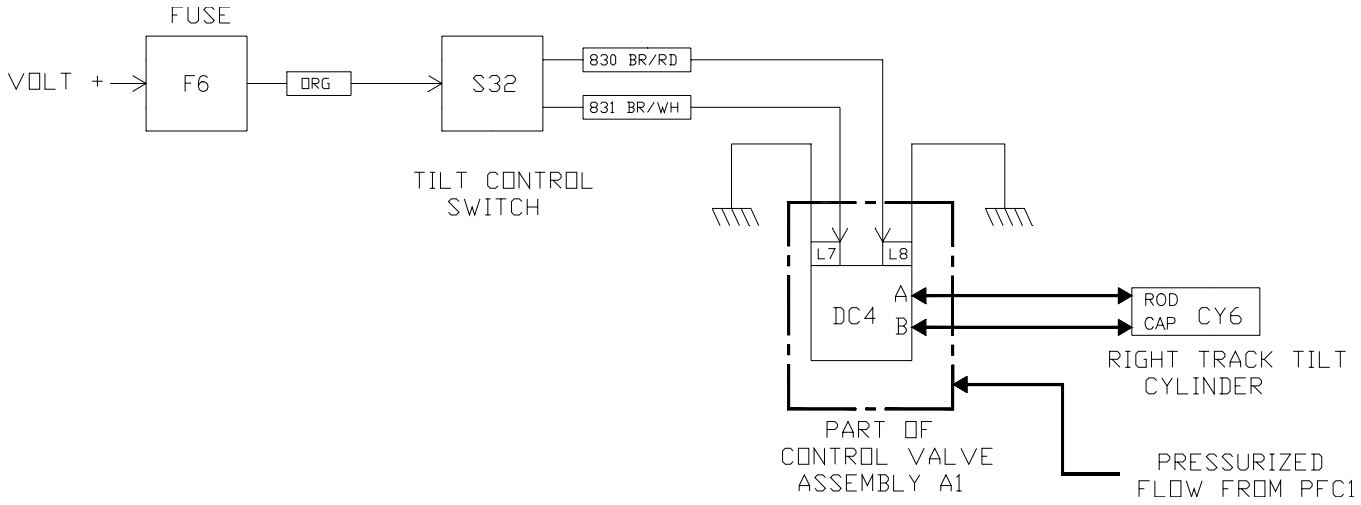
Cylinder - Extend (Tilt Inward)

When the left level control switch S31 is pushed UP, a voltage path is complete to energize solenoid L6 of directional control valve section A1DC3. The valve spool will shift, directing oil through the B port of valve section DC3 to cap (base) end of cylinder CY5.

Cylinder - Retract (Tilt Outward)

When the switch is pushed DOWN, a voltage path is complete to energize solenoid L5 of directional control valve section A1DC3. The valve spool will shift, directing oil through the A port of the valve section DC3 to rod end of cylinder CY5.

RIGHT TRACK TILT CIRCUIT



Operation

The control valve assembly A1 receives pressurized oil flow from piston pump PFC1. The right manual tilt control switch S32 receives power from a 5-amp fuse F6.

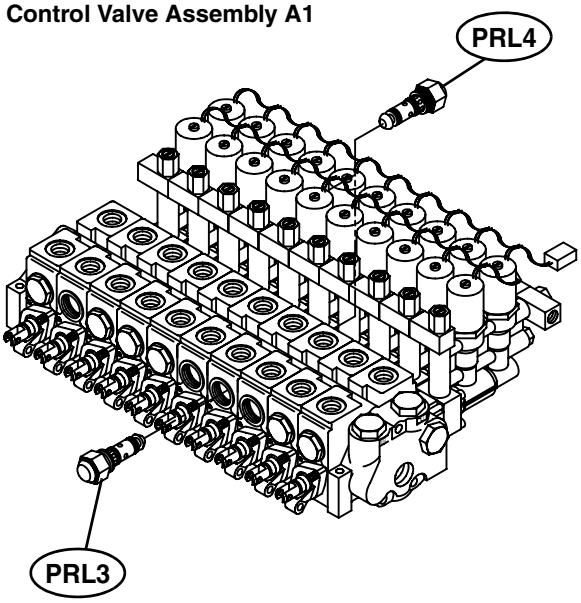
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Port Relief Valves

The right track tilt circuit utilizes relief valves installed in the valve section to control circuit pressure during trenching. Valve PRL3 limits circuit pressure to 1200 psi (83 bar) when cylinders are extending. Valve PRL4 limits circuit pressure to 1500 psi (103 bar) when the cylinders are retracting.

Control Valve Assembly A1



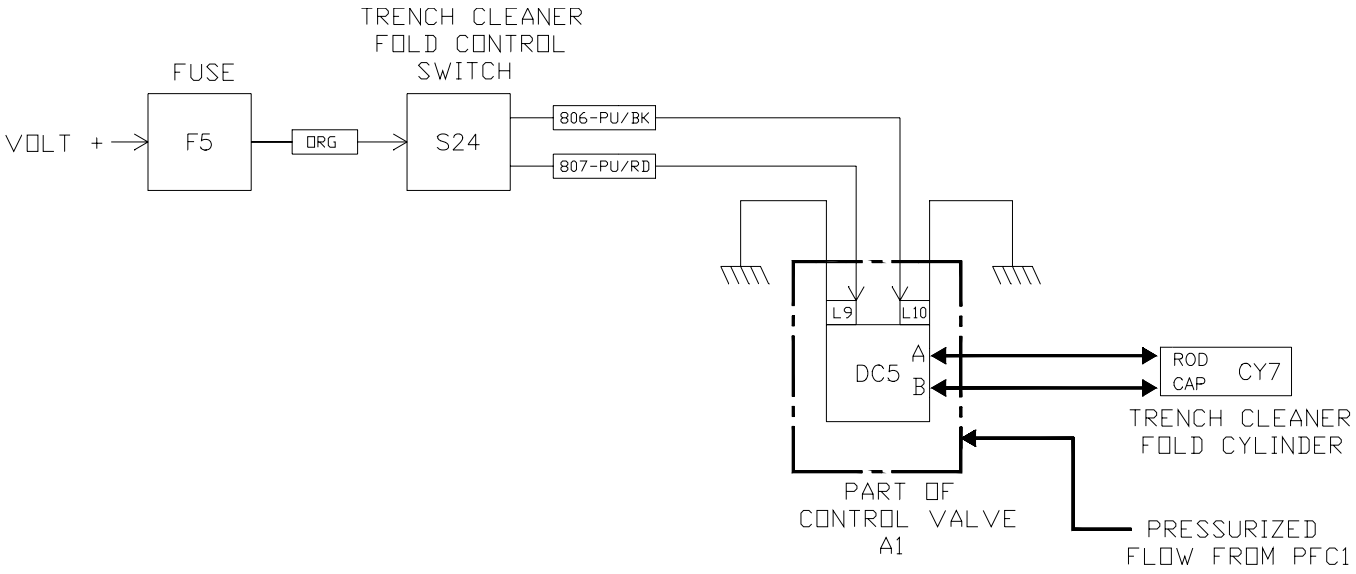
Cylinder - Extend (Tilt Inward)

When the right level control switch S32 is pushed UP, a voltage path is complete to energize solenoid L8 of directional control valve section A1DC4. The valve spool will shift, directing oil through the B port of valve section DC4 to cap (base) end of cylinder CY6.

Cylinder - Retract (Tilt Outward)

When the switch is pushed DOWN, a voltage path is complete to energize solenoid L7 of directional control valve section A1DC4. The valve spool will shift, directing oil through the A port of the valve section DC4 to rod end of cylinder CY6.

TRENCH CLEANER FOLD CIRCUIT



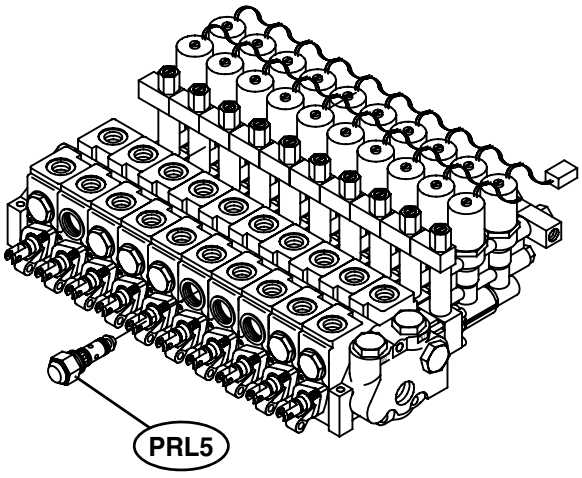
Operation

The control valve assembly A1 receives pressurized oil flow from piston pump PFC1. The trench cleaner fold control switch S24 receives power from a 5-amp fuse F9.

Port Relief Valve

The trench cleaner fold circuit utilizes a relief valve installed in the valve section to control circuit pressure during trenching. Valve PRL5 limits circuit pressure to 3000 psi (207 bar) when cylinder is extending.

Control Valve Assembly A1



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Cylinder - Extend (Lower)

When the trench cleaner fold control switch S24 is pushed DOWN, a voltage path is complete to energize solenoid L10 of directional control valve section A1DC5. The valve spool will shift, directing oil through the B port of valve section DC5 to cap (base) end of cylinder CY7.

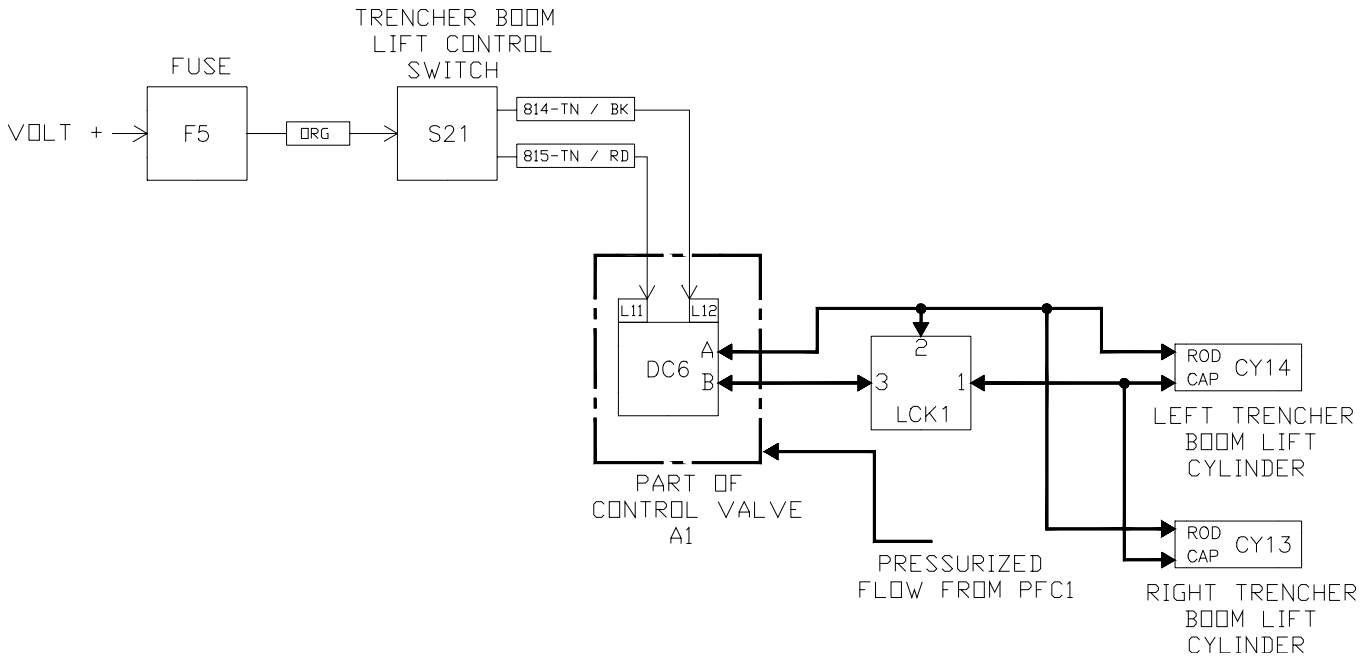
Cylinder - Retract (Raise)

When the switch is pushed UP, a voltage path is complete to energize solenoid L9 of directional control valve section A1DC5. The valve spool will shift, directing oil through the A port of the valve section DC5 to rod end of cylinder CY7.

Counterbalance Valve

The trench cleaner fold cylinder incorporates a counterbalance valve (not shown), designed to counteract the weight of the trench cleaner when it is lowered. The valve will control the rate of decent and work as a lock valve when the control is non-actuated to keep cylinder from seeping down. The valve also ensures the cylinder will not move if a hose or fitting fails.

TRENCHER BOOM LIFT CIRCUIT



Operation - Standard Configuration

The control valve assembly A1 receives pressurized oil flow from piston pump PFC1. The trencher boom lift control switch S21 receives power from a 5-amp fuse F9.

Continued on next page...

Cylinder - Extend (Lower)

When the trencher boom lift control switch S21 is pushed DOWN, a voltage path is complete to energize solenoid L12 of directional control valve section A1DC6. The valve spool will shift, directing oil through the B port of valve section DC6, through lock valve LCK1, to cap (base) end of cylinders CY13 & CY14.

Cylinder - Retract (Raise)

When the switch is pushed UP, a voltage path is complete to energize solenoid L11 of directional control valve section A1DC6. The valve spool will shift, directing oil through the A port of the valve section DC6 to rod end of cylinders CY13 & CY14.

Lock Valve LCK1

The lock valve LCK1 is separate from the cylinders and control valve. The valve locks oil in the cylinders and prevents the trencher from working its way out of the ground when operating as a result of oil seeping past the valve spool.

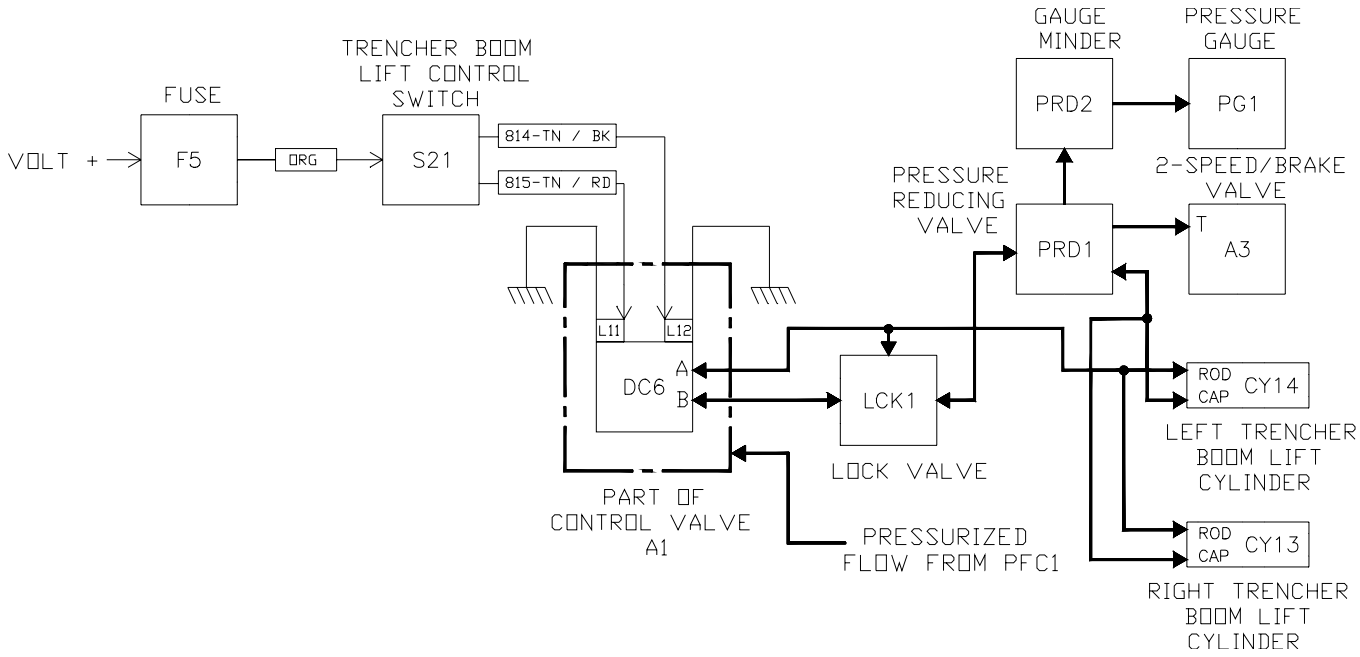
Counterbalance Valves

The trencher boom lift cylinders incorporate counterbalance valves (not shown) designed to counteract the weight of the boom when it is lowered. The valves control the rate of decent and work as a lock valve when the control is non-actuated to keep cylinders from seeping down. The valves also ensure the cylinders will not move if a hose or fitting fails.

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Operation - Optional Auto Down Pressure Configuration



The purpose of the auto down pressure option is to provide a constant down pressure on the boom that can be varied. This circuit is generally used with a tile boot or other hydraulic trench cleaner shoe. The angle of the shoe is varied in this configuration and thereby pushes up or down on the boom.

With the auto down pressure option, the boom is raised or lowered in response to the changing of the shoe angle. This setup is typically used when depth is being controlled by a laser for maintaining grade.

Cylinder - Extend (Lower)

When the trencher boom lift control switch S21 is pushed DOWN, a voltage path is complete to energize solenoid L12 of directional control valve section A1DC6. The valve spool will shift, directing oil through the B port of valve section DC6, through lock valve LCK1, pressure reducing valve PRD1, then to cap (base) end of cylinders CY13 & CY14.

Cylinder - Retract (Raise)

When the switch is pushed UP, a voltage path is complete to energize solenoid L11 of directional control valve section A1DC6. The valve spool will shift, directing oil through the A port of the valve section DC6 to rod end of cylinders CY13 & CY14.

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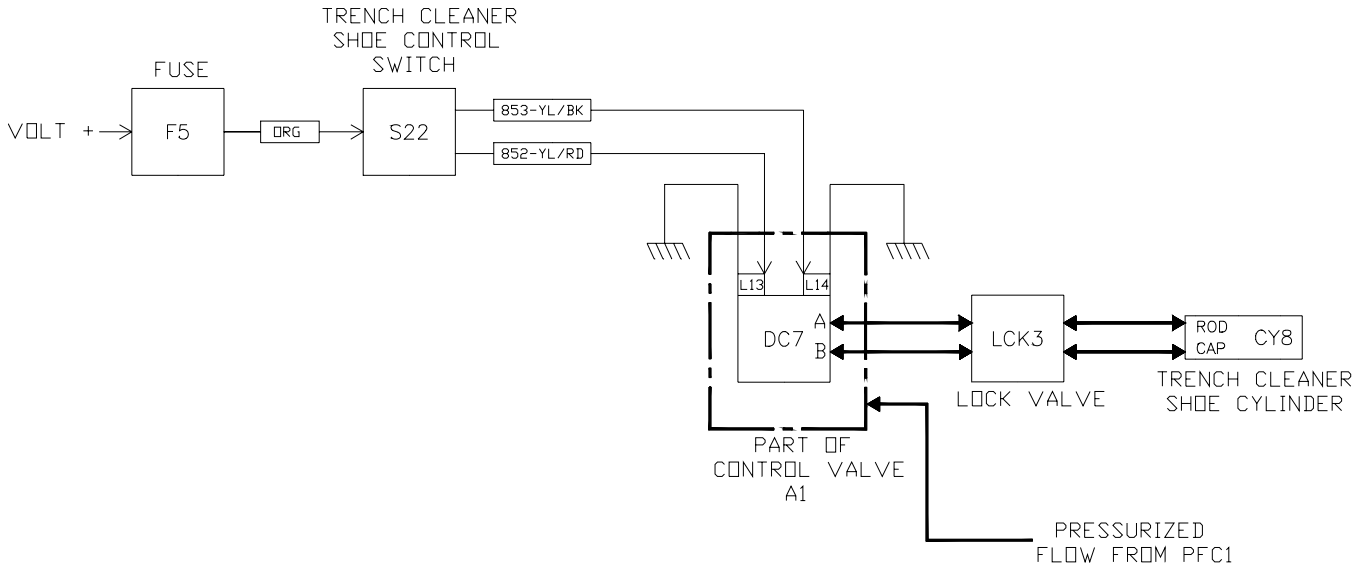
Lock Valve LCK1

The lock valve LCK1 is separate from the cylinders and control valve. The valve locks oil in the cylinders and prevents the trencher from working its way out of the ground when operating as a result of oil seeping past the valve spool.

Counterbalance Valves

The trencher boom lift cylinders incorporate counterbalance valves (not shown) designed to counteract the weight of the boom when it is lowered. The valves control the rate of decent and work as a lock valve when the control is non-actuated to keep cylinders from seeping down. The valves also ensure the cylinders will not move if a hose or fitting fails.

TRENCH CLEANER SHOE CIRCUIT (OPTIONAL)



Operation

The control valve assembly A1 receives pressurized oil flow from piston pump PFC1. The trench cleaner shoe control switch S22 receives power from a 5-amp fuse F9.

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Cylinder - Extend (Lower)

When the trench cleaner shoe control switch S24 is pushed UP, a voltage path is complete to energize solenoid L14 of directional control valve section A1DC7. The valve spool will shift, directing oil through the B port of valve section DC7 to cap (base) end of cylinder CY8.

Cylinder - Retract (Raise)

When the switch is pushed DOWN, a voltage path is complete to energize solenoid L3 of directional control valve section A1DC7. The valve spool will shift, directing oil through the A port of the valve section DC7 to rod end of cylinder CY8.

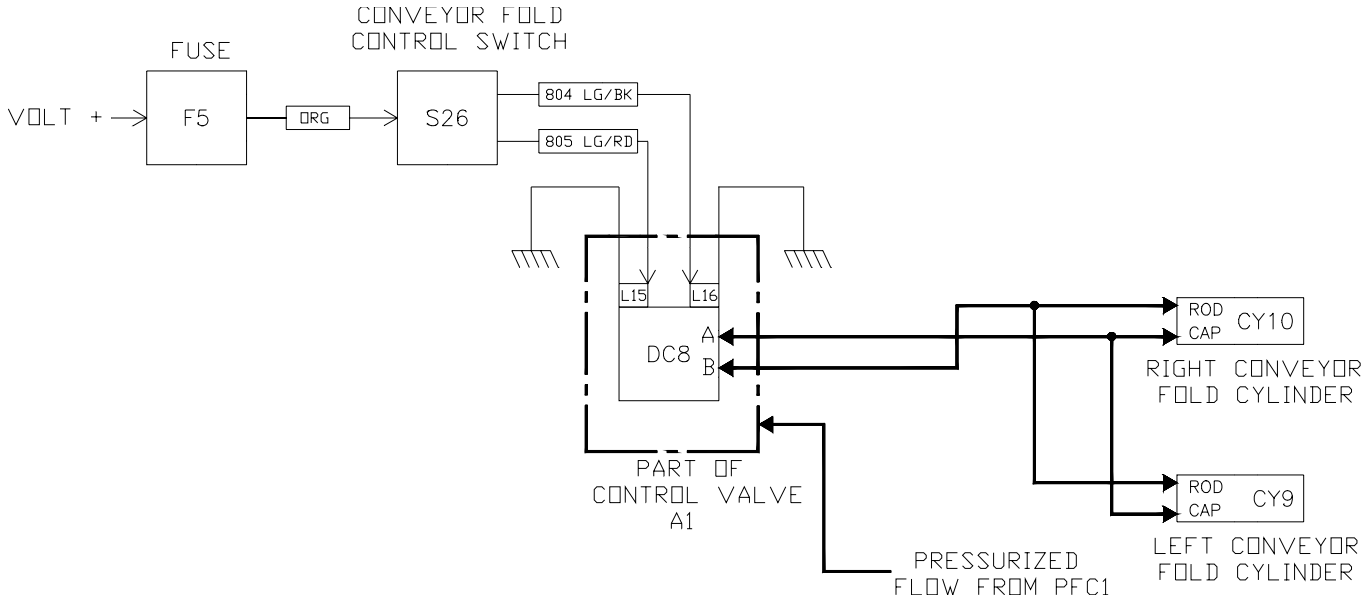
Lock Valve LCK3

The lock valve LCK3 is separate from the cylinder and control valve. The valve locks oil in the cylinder and prevents the trench cleaner shoe from moving when operating as a result of oil seeping past the valve spool.

Counterbalance Valve

The trench cleaner shoe cylinder incorporates a counterbalance valve (not shown), designed to counteract the weight of the shoe when it is lowered. The valve will control the rate of decent and work as a lock valve when the control is non-actuated to keep cylinder from seeping down. The valve also ensures the cylinder will not move if a hose or fitting fails.

CONVEYOR FOLD CIRCUIT (OPTIONAL)



Operation

The control valve assembly A1 receives pressurized oil flow from piston pump PFC1. The conveyor fold control switch S26 receives power from a 5-amp fuse F9.

Continued on next page...

Cylinder - Extend (Lower)

When the conveyor fold control switch S26 is pushed DOWN, a voltage path is complete to energize solenoid L15 of directional control valve section A1DC8. The valve spool will shift, directing oil through the A port of valve section DC8 to cap (base) end of cylinders CY9 & CY10.

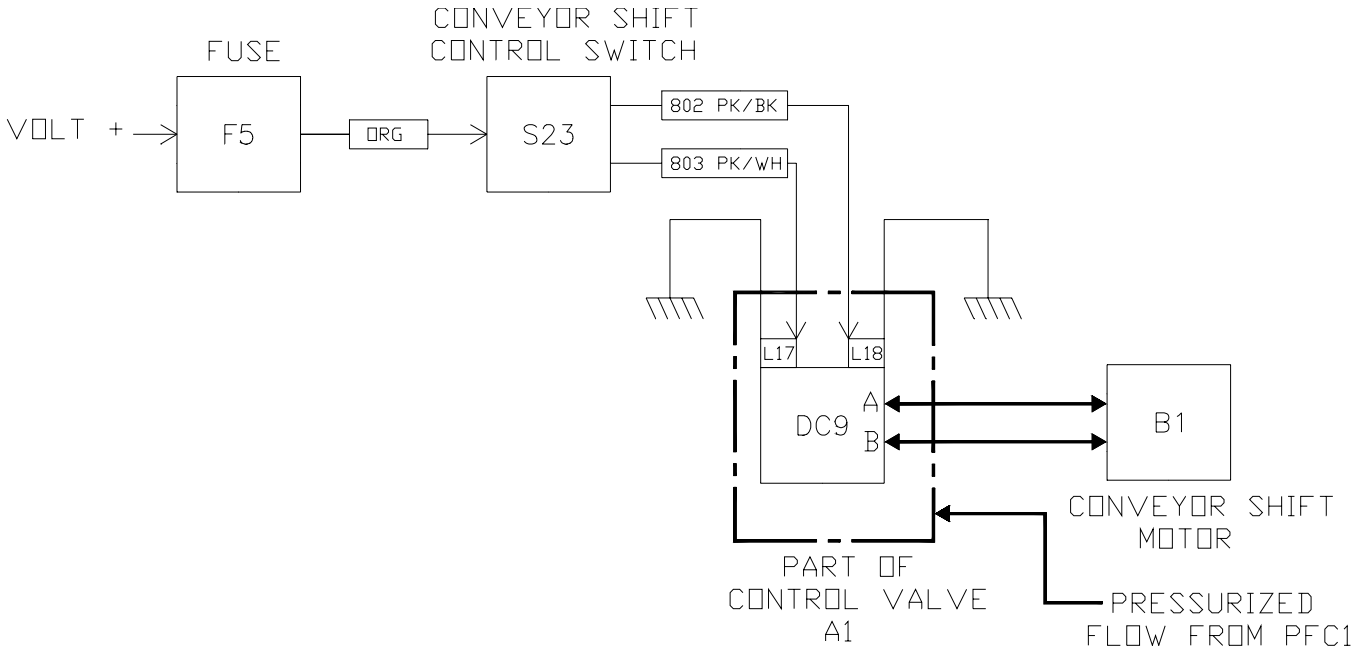
Cylinder - Retract (Raise)

When the switch is pushed UP, a voltage path is complete to energize solenoid L16 of directional control valve section A1DC8. The valve spool will shift, directing oil through the B port of the valve section DC8 to rod end of cylinders CY9 & CY10.

Counterbalance Valve

The conveyor fold cylinders incorporate counterbalance valves (not shown), designed to counteract the weight of the conveyor when it is lowered. The valve will control the rate of decent and work as a lock valve when the control is non-actuated to keep cylinders from seeping down. The valve also ensures the cylinders will not move if a hose or fitting fails.

CONVEYOR SHIFT CIRCUIT (OPTIONAL)



Operation

The control valve assembly A1 receives pressurized oil flow from piston pump PFC1. The conveyor shift control switch S23 receives power from a 5-amp fuse F9.

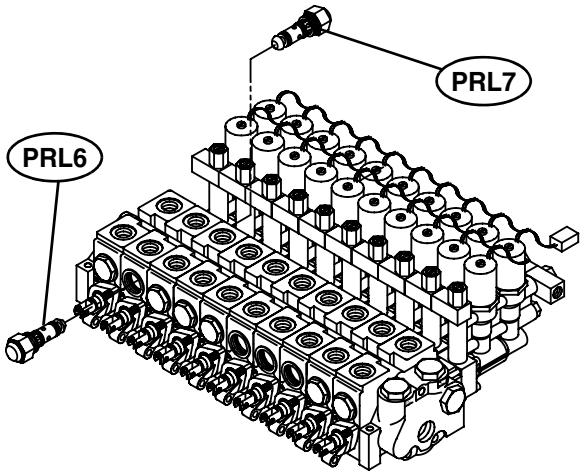
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Port Relief Valves

The conveyor shift circuit utilizes relief valves installed in the valve section to control circuit pressure during trenching. Valves PRL6 & PRL7 limit circuit pressure to 1200 psi (83 bar) when the motor is rotating in either direction.

Control Valve Assembly A1



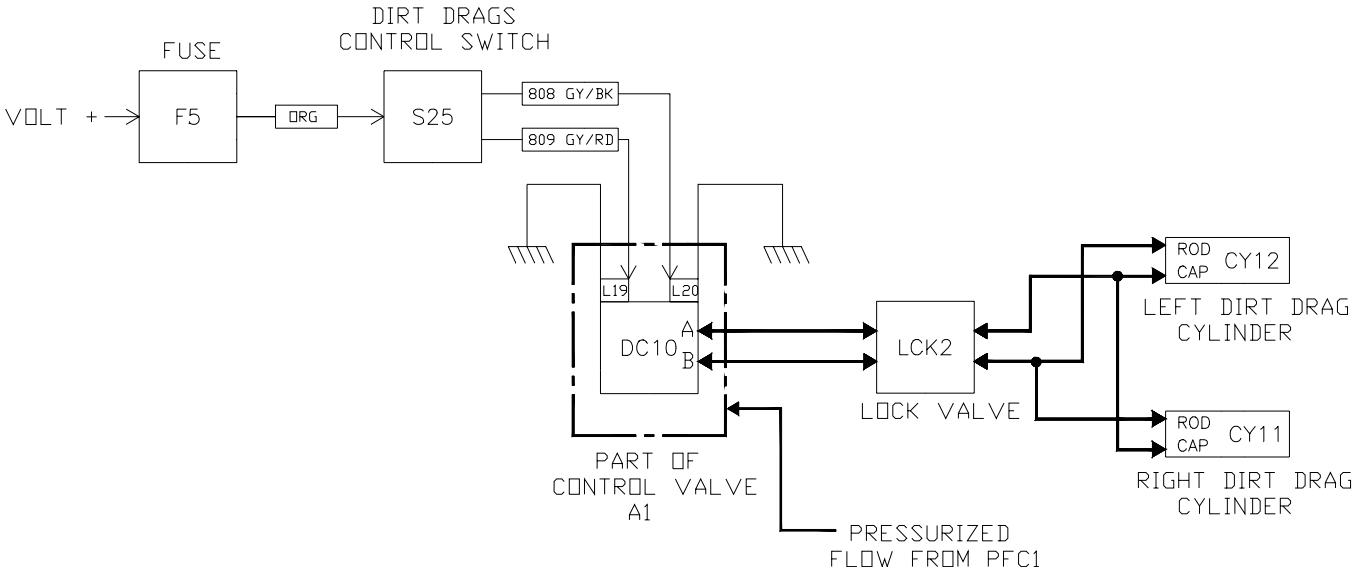
Conveyor - Shift Left

When the conveyor shift control switch S23 is pushed UP, a voltage path is complete to energize solenoid L18 of directional control valve section A1DC9. The valve spool will shift, directing oil through the B port of valve section DC9 to conveyor shift motor B1.

Conveyor - Shift Right

When the switch is pushed DOWN, a voltage path is complete to energize solenoid L17 of directional control valve section A1DC9. The valve spool will shift, directing oil through the A port of the valve section DC9 to conveyor shift motor B1.

DIRT DRAGS CIRCUIT (OPTIONAL)



Operation

The control valve assembly A1 receives pressurized oil flow from piston pump PFC1. The dirt drags control switch S25 receives power from a 5-amp fuse F9.

Cylinder - Extend (Lower)

When the dirt drags control switch S25 is pushed DOWN, a voltage path is complete to energize solenoid L19 of directional control valve section A1DC10. The valve spool will shift, directing oil through the A port of valve section DC10, through lock valve LCK2, to cap (base) end of cylinders CY11 & CY12.

Cylinder - Retract (Raise)

When the switch is pushed UP, a voltage path is complete to energize solenoid L20 of directional control valve section A1DC10. The valve spool will shift, directing oil through the B port of the valve section DC10, through lock valve LCK2, to rod end of cylinders CY11 & CY12.

Lock Valve LCK2

The lock valve LCK2 is separate from the cylinders and control valve. The valve locks oil in the cylinders and prevents the dirt drags from moving out of position when operating as a result of oil seeping past the valve spool.

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Chapter 6: Implement Subsystem

Section B: Troubleshooting

OVERVIEW



WARNING: Pressurized fluid can penetrate body tissue and result in serious injury or death. Leaks can be invisible. Keep away from any suspected leak. Relieve pressure in the hydraulic system before searching for leaks, disconnecting hoses, or performing any other work on the system. If you must pressurize the system to find a suspected leak, use an object such as a piece of wood or cardboard rather than your hands. When loosening a fitting where some residual pressure may exist, slowly loosen the fitting until oil begins to leak. Wait for leaking to stop before disconnecting the fitting. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

Pretest Inspection

Before beginning any troubleshooting, review information in the General Information Chapter under “Troubleshooting Guidelines,” page 1-9.

If a malfunction occurs, do the following visual checks to inspect for obvious signs of failures before any testing is performed.

- Check for any obvious mechanical failures such as, broken linkages, cables, sprockets, chains, sheaves, pulleys, belts, and so on.
- Check hydraulic oil level in tank, especially if all implement circuits or other subsystems are experiencing similar performance problems.
- Check hydraulic circuits for any obvious failures such as, broken, kinked, loose, or leaking hoses and fittings on supply, pressure, and return to hydraulic components. Also, check for broken, missing, corroded, or loose connections and wires that supply ground and power to electrical components.

Correct any problems found during the inspection. Operate the machine to verify the malfunction is fixed.

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Fault Chart

If no problems were found during the pretest inspection, refer to the fault chart on page 6B-3 and continue troubleshooting. The possible malfunctions listed do not cover everything that could go wrong with the circuits. They are meant to give a technician a logical place to begin, based on performance observations.

Test Equipment Needed

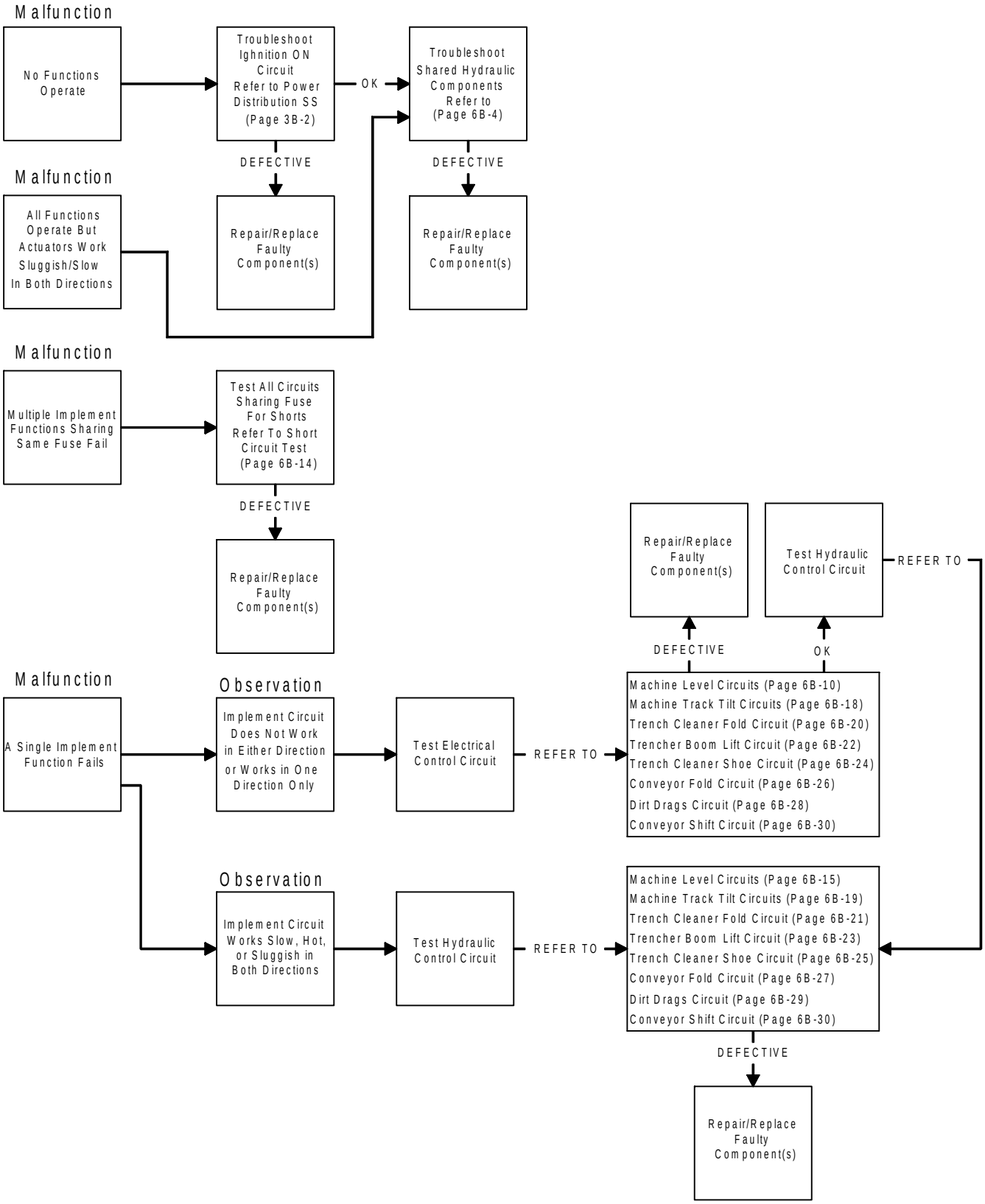
IMPORTANT: The pressure and flow ratings of the test equipment used to conduct the following hydraulic test procedures must be equal to, or greater than the pressure and flow ratings of the circuit being tested.

- Pressure Gauge
- Vacuum Gauge
- Phototachometer
- Flow Meter
- Pyrometer
- Digital Multimeter

Component Repair/Replace

If troubleshooting procedures determine a component is in need of repair or replacement, refer to section C for the appropriate repair procedures for those components.

FAULT CHART


Malfunction
No Functions Operate
Troubleshoot Ignhition ON Circuit Refer to Power Distribution SS (Page 3B-2)
OK
Troubleshoot Shared Hydraulic Components Refer to (Page 6B-4)
DEFECTIVE
DEFECTIVE
Repair/Replace Faulty Component(s)
Repair/Replace Faulty Component(s)
Malfunction
All Functions Operate But Actuators Work Sluggish/Slow In Both Directions
Malfunction
Multiple Implement Functions Sharing Same Fuse Fail
Test All Circuits Sharing Fuse For Shorts Refer To Short Circuit Test (Page 6B-14)
DEFECTIVE
Repair/Replace Faulty Component(s)
Repair/Replace Faulty Component(s)
Test Hydraulic Control Circuit
REFER TO
DEFECTIVE
OK
Malfunction
A Single Implement Function Fails
Observation
Implement Circuit Does Not Work in Either Direction or Works in One Direction Only
Test Electrical Control Circuit
REFER TO
Machine Level Circuits (Page 6B-10)
Machine Track Tilt Circuits (Page 6B-18)
Trench Cleaner Fold Circuit (Page 6B-20)
Trencher Boom Lift Circuit (Page 6B-22)
Trench Cleaner Shoe Circuit (Page 6B-24)
Conveyor Fold Circuit (Page 6B-26)
Dirt Drags Circuit (Page 6B-28)
Conveyor Shift Circuit (Page 6B-30)
Observation
Implement Circuit Works Slow, Hot, or Sluggish in Both Directions
Test Hydraulic Control Circuit
REFER TO
Machine Level Circuits (Page 6B-15)
Machine Track Tilt Circuits (Page 6B-19)
Trench Cleaner Fold Circuit (Page 6B-21)
Trencher Boom Lift Circuit (Page 6B-23)
Trench Cleaner Shoe Circuit (Page 6B-25)
Conveyor Fold Circuit (Page 6B-27)
Dirt Drags Circuit (Page 6B-29)
Conveyor Shift Circuit (Page 6B-30)
DEFECTIVE
Repair/Replace Faulty Component(s)

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SHARED HYDRAULIC COMPONENTS

All of the machine subsystems share the Fluid Conditioning subsystem components including a common hydraulic tank, hydraulic oil, return filters, breather and so on. The implement circuits all share the same pump and directional control valve assembly. When all implement circuits are operating abnormally or not operating at all, these shared components should be investigated.

Fluid Conditioning Subsystem

1. Refer to the Fluid Conditioning subsystem troubleshooting section 3B for information on checking and inspecting the shared hydraulic components. If Fluid Conditioning subsystem is OK, continue by testing the Implement subsystem shared hydraulic components starting with pump PFC1.

Implement Pump PFC1

2. The pump test procedure involves testing the pump for excessive leakage (see following page). If the pump leakage approaches or exceeds the design specification, all the implement circuits can be affected. If pump appears to be within design specification after testing, inspect the directional control valve assembly A1 sections for excessive leakage.

Directional Control Valve Assembly A1

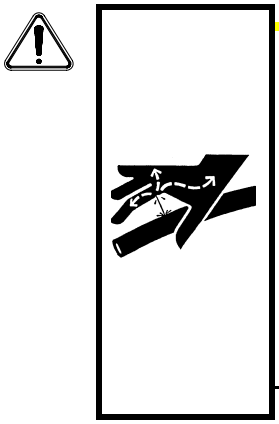
Contaminants in hydraulic oil, over a period of time, can build up between the moving parts and housings and cause valve spools, check balls, and other components to stick. Leaking O-ring seals and backup washers can also affect the output flow of valves.

Abrasive wear will gradually increase the radial and diametrical clearances, resulting in increased cross-port leakage. Inspecting for excessive wear would involve removing the valve sections and pressure relief cartridges one at a time from the stack and checking the valve seats, O-ring seals, backup washers, spools, and check balls. Replace any visually worn components. Thoroughly clean the valve body sections and install back to the stack.

Refer to the Implement subsystem Repair section 6C for information on inspecting and repairing the valve components.

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Pump PFC1 Hydraulic Test Procedure



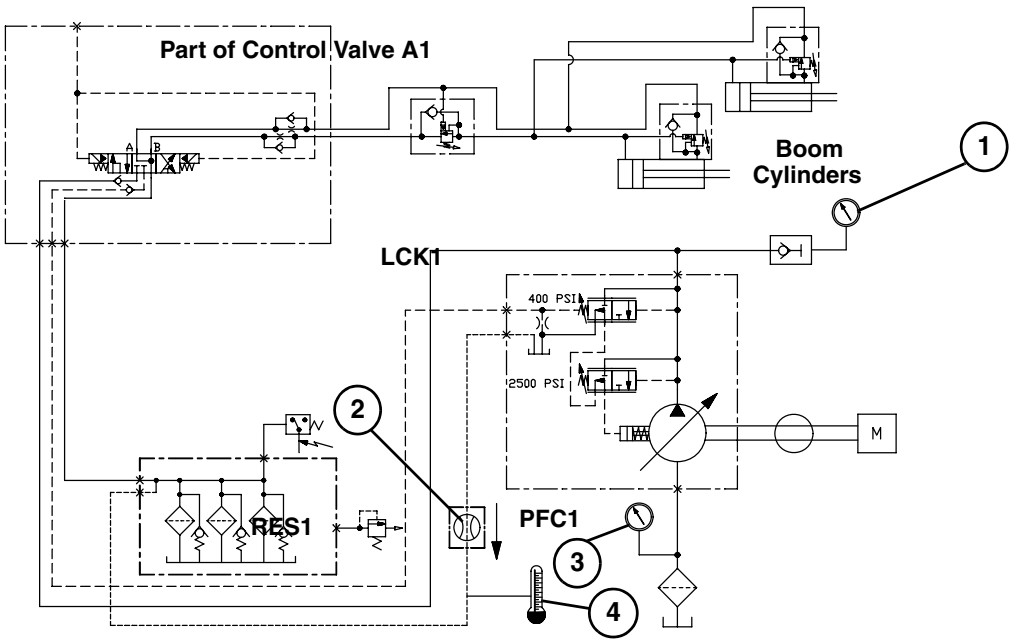
WARNING: Pressurized fluid can penetrate body tissue and result in serious injury or death. Leaks can be invisible. Keep away from any suspected leak. Relieve pressure in the hydraulic system before searching for leaks, disconnecting hoses, or performing any other work on the system. If you must pressurize the system to find a suspected leak, use an object such as a piece of wood or cardboard rather than your hands. When loosening a fitting where some residual pressure may exist, slowly loosen the fitting until oil begins to leak. Wait for leaking to stop before disconnecting the fitting. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

NOTE: To conduct this test safely and accurately, refer to the diagram below for correct placement of diagnostic equipment.

To record test data, make a copy of the test worksheet on page 6B-31.

IMPORTANT: The pressure and flow ratings of the test equipment used to conduct the following hydraulic test procedures must be equal to, or greater than the pressure and flow ratings of the circuit being tested. Ensure any hoses or fittings that are added to the test equipment are the same size and rating as hoses and fittings installed in the hydraulic circuit. Mismatched hose or fitting sizes can result in erroneous pressure indications. Mismatched pressure ratings can result in leakage or personal injury.

This test procedure will determine:



- If pump inlet restriction is consistent with design specification

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- If compensator setting is consistent with design specification
- The amount of leakage across the ports of pump

1. Shut down engine.
2. Turn ground disconnect switch to the DISABLE position.
3. Install flow meter **(2)** in series with case drain line at the case drain port of the pump.
4. Install pressure gauge **(1)** in implement pressure diagnostic port.
5. Install vacuum gauge **(3)** in parallel with connector at the inlet port of pump.
6. Make a photocopy of the test worksheet on page **6B-31**.
7. Turn ground disconnect switch to ENABLE position. Start engine and inspect the test equipment for leaks.

NOTE: If catastrophic failure is suspected, do not run engine for longer than absolutely necessary to determine its condition. If metal fragments are found in the hydraulic lines, outlet port of pump, return filters, and/or tank, DO NOT restart the pump. Replace pump.

8. Allow system to warm up to approximately 130°F (54°C).

NOTE: For accurate test results, check and adjust (if necessary) the pump compensator settings. Refer to page **6B-9**.

9. Set engine speed to full throttle (2350 rpm) on TEC 2000 LCD display.
10. Record on test worksheet pump inlet restriction on vacuum gauge **(3)**.
11. If pump inlet restriction is within design specification 3″ Hg (76 mm) continuous max., continue with test procedure. If pump inlet restriction is inconsistent with design specification, refer to page **4B-1** and ensure fluid level is correct and suction screen is not clogged. Continue with test procedure when pump inlet restriction is within design specification.

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12. Operate pump at no-load. Record on test worksheet:

- Flow indicated on flow meter **(2)**.
- Pressure indicated on vacuum gauge **(3)**.
- Fluid temperature indicated on pyrometer **(4)**.

13. Operate pump at full load by activating the boom lift circuit and record on test worksheet:

- Pressure indicated on pressure gauge **(1)**.
- Engine speed indicated on TEC 2000 LCD display.
- Flow indicated on flow meter **(2)**.
- Fluid temperature indicated on pyrometer **(4)**.

14. Shut down engine and analyze test results.

15. At conclusion of test procedure, remove test equipment, reconnect the hydraulic lines, and tighten the connectors securely.

16. Start engine and check connectors for leaks.

Analyzing Test Results

Diagnostic Observation 1:

- Flow meter **(2)** indicates a nominal increase in case drain flow as the pressure drop across the pump ports increases. The flow increase does not exceed the anticipated flow decrease relative to the volumetric efficiency rating of the pump - 8 gpm (30 L/min) max. and nominal decrease in engine speed.
- The operating temperature of the fluid indicated on pyrometer **(4)** remains within design specification.
- Engine speed indicated on TEC 2000 LCD display remains within design specification.
- Inlet restriction indicated on vacuum gauge **(3)** remains within design specification - 3″ Hg (76 mm) continuous Max.

Diagnosis: The pump appears to be in satisfactory condition.

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Diagnostic Observation 2:

Flow meter **(2)** indicates a moderate to high increase in case drain flow as the pressure drop across the pump ports increases. The flow increase does not exceed 30% of the theoretical or no-load flow - 8 gpm (30 L/min).

Pyrometer **(4)** indicates a moderate increase in the operating temperature of the fluid.

Engine speed indicated on TEC 2000 LCD display remains within design specification.

Pump inlet restriction indicated on vacuum gauge **(3)** remains within design specification - 3″ Hg (76 mm) continuous Max.

Diagnosis: The condition of the pump may be marginal. If there is an abnormal variation (reduction) in actuator speed which causes an unacceptable production loss, and/or a marked increase in the operating temperature of the fluid. Replace pump.

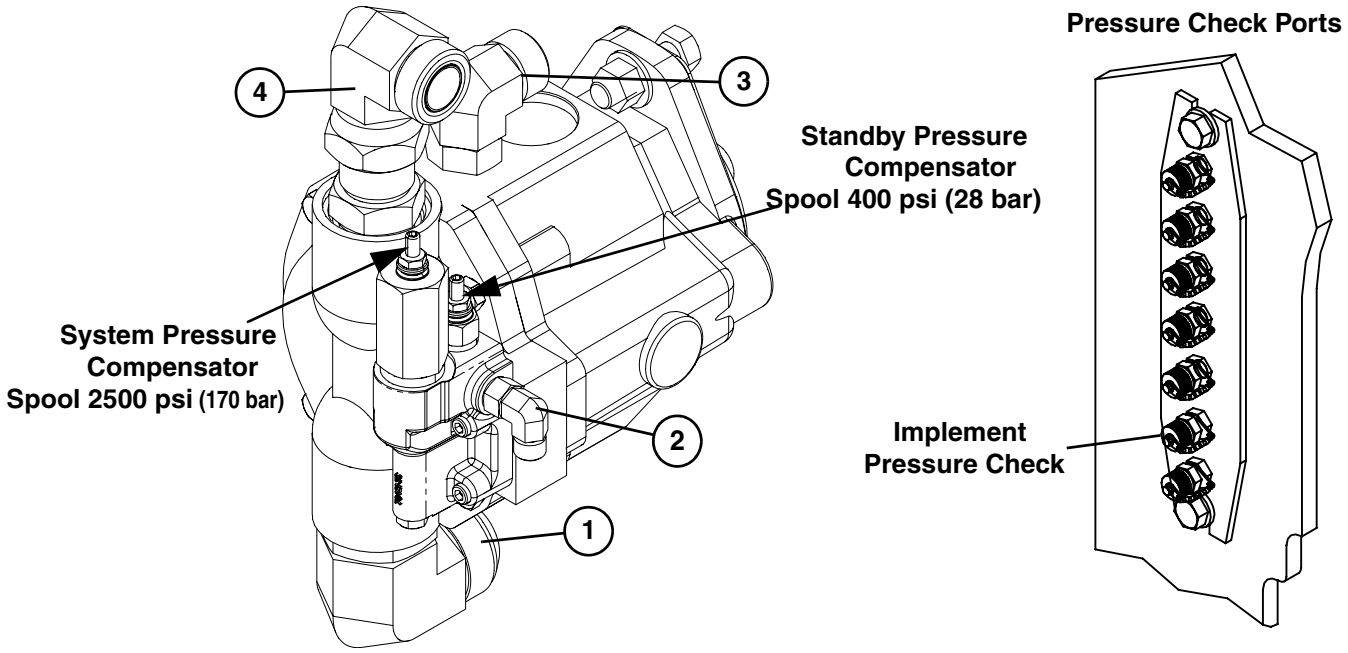
Diagnostic Observation 3:

- Flow meter **(2)** indicates a progressive flow increase as the pressure drop across the pump ports increase. The flow increase exceeds 30% of the theoretical or no-load flow - 8 gpm (30 L/min).
- Pyrometer **(4)** indicates a progressive increase in the operating temperature of the fluid which appears to level-off.
- Engine speed indicated on TEC 2000 LCD display remains within design specification.
- Pump inlet restriction indicated on vacuum gauge **(3)** remains within design specification - 3″ Hg (76 mm) continuous Max.

Diagnosis: A case drain flow increase of this magnitude will invariably cause an unacceptable loss in actuator speed. It could also cause a marked increase in the temperature of the fluid. If neglected, elevated fluid temperatures could lead to the degradation of the entire hydraulic system. Replace pump.

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Compensator - Check



Pump Port Designations

(1) Suction Port

(2) Load Sensing Port

(3) Case Drain Port

(4) Pressure Port

To adjust pressures:

1. Install a pressure gauge capable of at least 3000 psi (210 bar) on implement pressure check diagnostic fitting.
2. Start engine and ensure all controls and switches are in their NEUTRAL positions.

   Expected result: The pressure gauge should read 400 psi (28 bar). If not, adjust standby pressure to 400 psi (28 bar) using the screw on standby pressure compensator. Turn adjustment screw clockwise to increase pressure, counterclockwise to decrease pressure.
3. Run trencher boom lift cylinders to the end of their stroke (deadhead).

   Expected result: The pressure gauge should read 2500 psi (170 bar). If not, adjust system pressure to 2500 psi (170 bar) using the screw on system pressure compensator.

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4. Turn adjustment screw clockwise to increase pressure.

   Expected result: The pressure should gradually rise to 2500 psi (170 bar). If correct pressure cannot be obtained, the pressure-flow compensator assembly may be faulty.

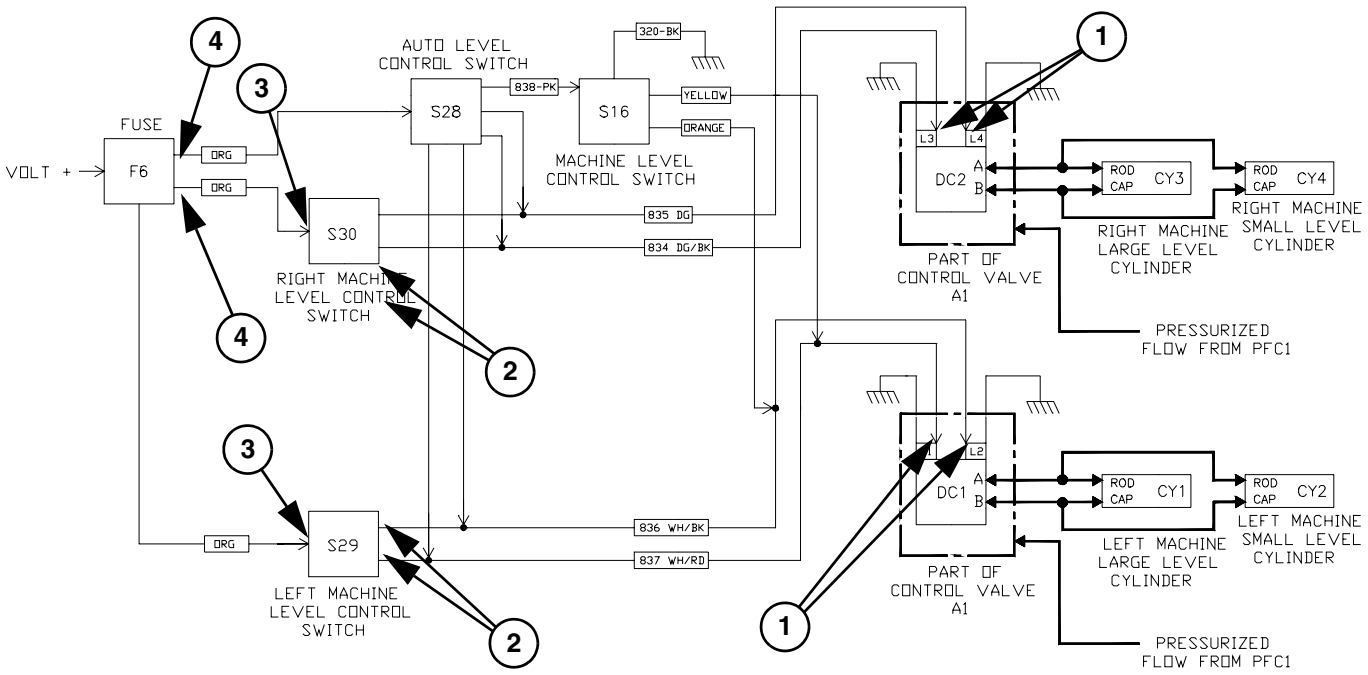
5. Replace pressure-flow compensator assembly. Refer to page 6C-3.

6. Repeat steps 1–4.

LEFT AND RIGHT MACHINE LEVEL CIRCUITS

Electrical Troubleshooting

The following procedures are used to test for opens, shorts or high resistance in the circuit. Begin testing the circuit for acceptable voltage. Refer to open circuit test page 6B-13.



Testing Sequence

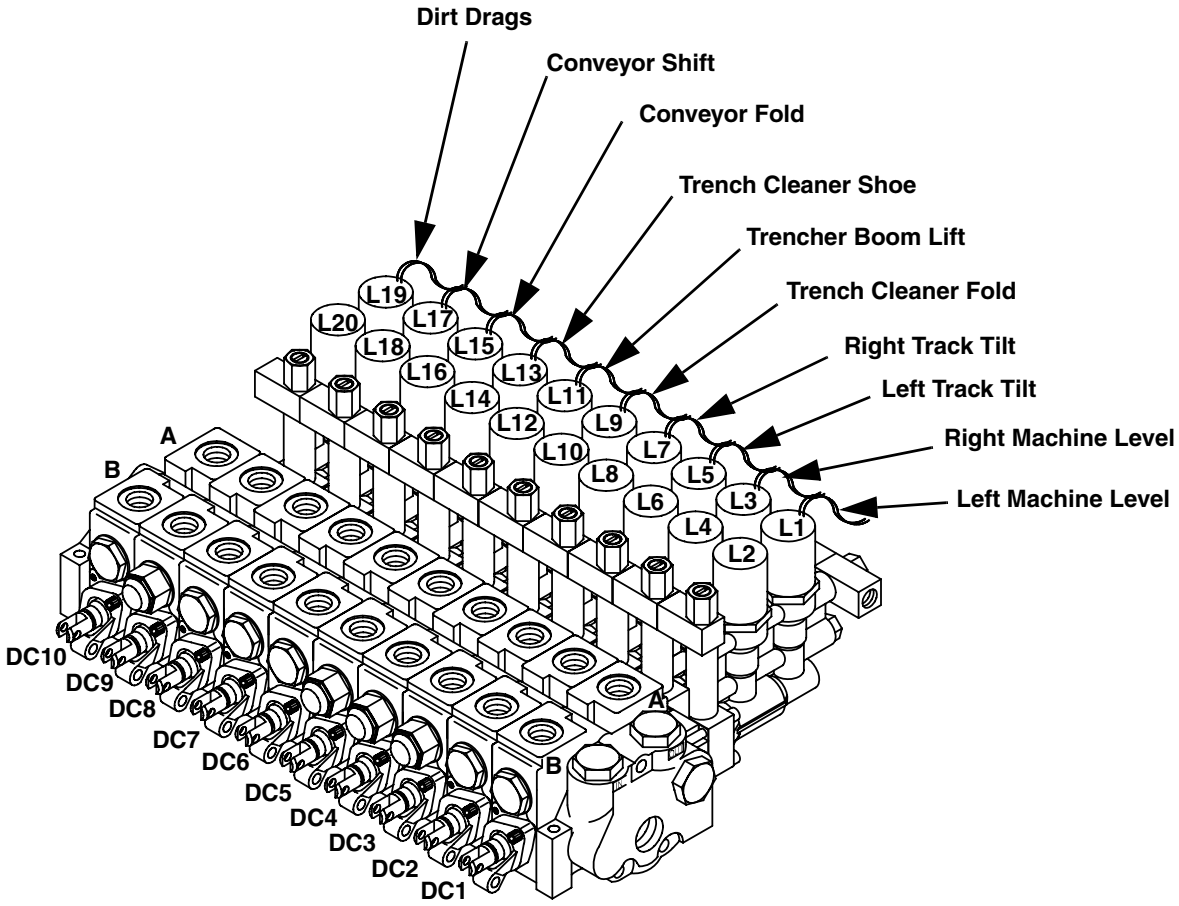
The testing sequence gives a troubleshooter a logical place to begin troubleshooting the electrical circuit inputs and outputs. The sequence test points start at the load **(1)** and work back through the complete circuit **(4)**.

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Control Valve Reference

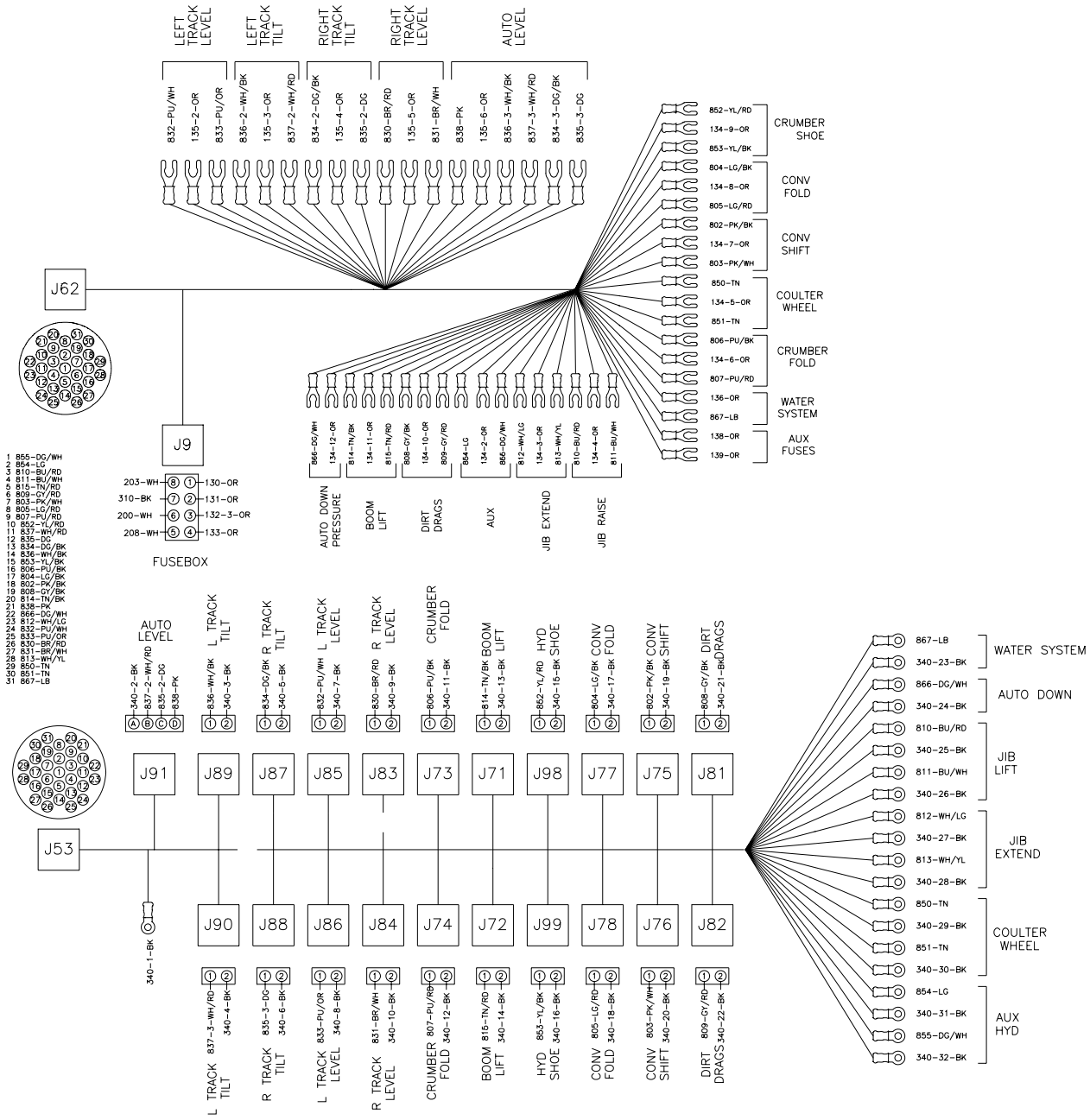
Refer to the graphic below and the wire harness diagram on the following page for solenoid, plug, and component terminal/pin reference. If necessary refer to the Addendum section in the rear of the manual for complete electrical schematic.



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Component Pin/ Terminal Reference



The diagram above represents the wire harness connections of the implement circuits/components. Use the diagram for pin, terminal, wire, and plug reference when testing circuits and components. Only the wire harness connections relevant to the implement control circuits are represented.

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NOTE: When testing voltage, the control switch of the circuit being tested must be activated before voltage can be present at the valves solenoid coils.

Open Circuit Test

1. Test for an open in the circuit by testing acceptable voltage on power input and output pins/terminals of plugs and components at test points shown on circuit diagram. Testing at these points, starting at the load **(1)** and working through the circuit will isolate the failed component by process of elimination. Continue through the steps until the open is found.

   Expected result: When the positive lead is placed before an open point, the meter will read full battery voltage, approximately 12 volts. When the lead is placed beyond the open, the meter will read no voltage, indicating that a complete circuit exists from the chassis ground to the point where voltage is last measured in the circuit.

   If battery voltage is measured at the valve solenoids **(1)**, unplug the wire harness at the solenoid and check coil for resistance.

   Expected result: The resistance should measure 8.3 Ω ± 1 . If not, replace the solenoid coil.

2. Once the open is found, turn ignition switch OFF, unplug wire harness at the suspected component and test component for continuity. If the component is OK, test wires connecting the component for continuity. Replace faulty component or section of wire harness. If battery voltage is measured at points, continue next by measuring for voltage on ground side.

3. Normal voltage should measure 0.0–0.5 volts. If battery voltage is measured on ground side, a poor connection or broken wire/cable is indicated. Test wires connecting the component for continuity. Replace faulty section of wire harness.

High Resistance Test

Measurements taken from a multimeter can be used to troubleshoot for unwanted resistance. Use multimeter to test for lower than normal battery voltage (voltage drop) while moving to accessible points in the circuit wiring. Replace section of failed wire harness. Refer to the diagram on page **6B-10**.

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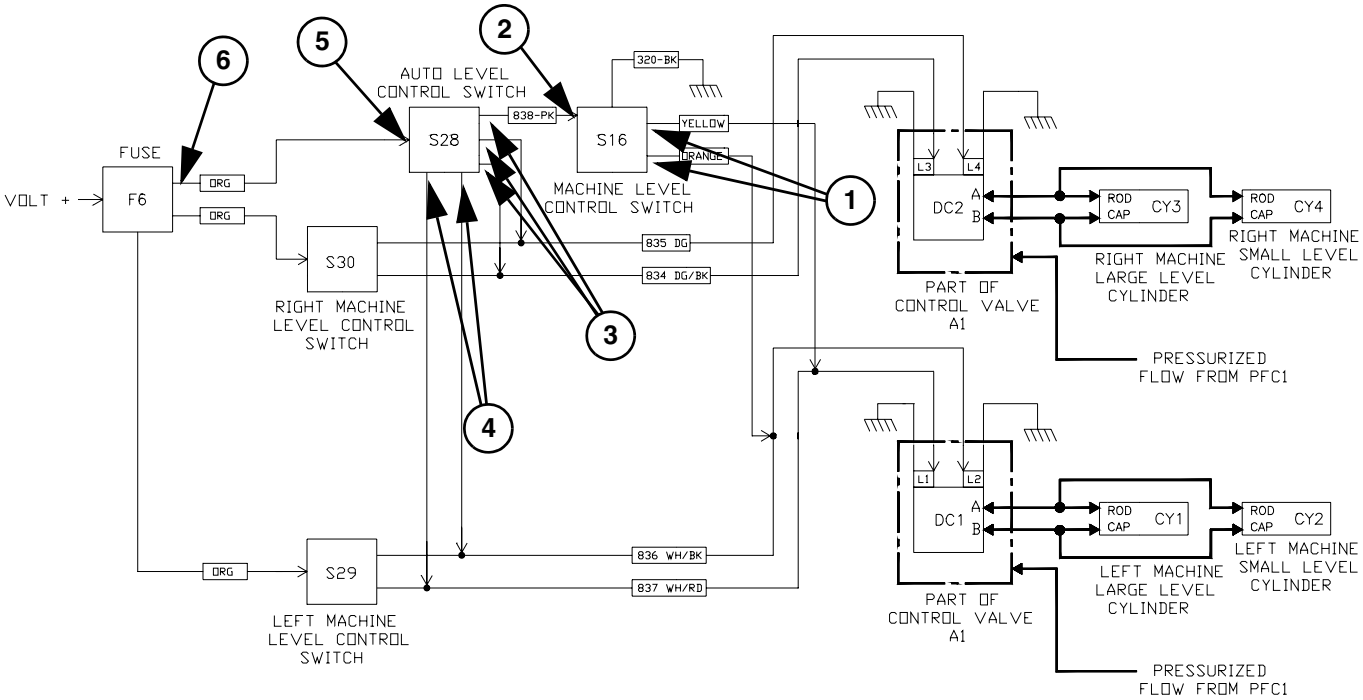
Short Circuit Test

1. Test for a short in the circuit. When testing the circuit for a short, turn ignition switch OFF and set multimeter to measure resistance (Ω). Work through the circuit, if the meter measures resistance through the complete circuit, it may be an intermittent problem causing the short. In that case, repeat the procedure and move the wiring harness or tap on components while watching for a sudden drop in resistance (Ω).

   Expected result: If the voltage side of the circuit is shorted to ground, the meter will read 0.0 Ω This indicates there is no resistance between check points (a dead short). Work through the circuit until the short is located. When the short is removed, the meter will return to a resistance reading.

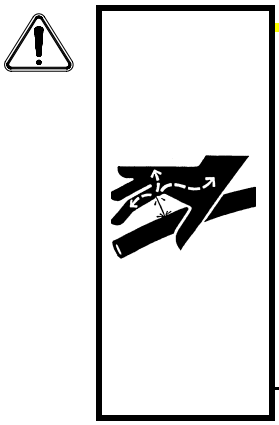
2. Repair or replace faulty component or section of wire harness. Check circuit for function.

Auto Level Circuit



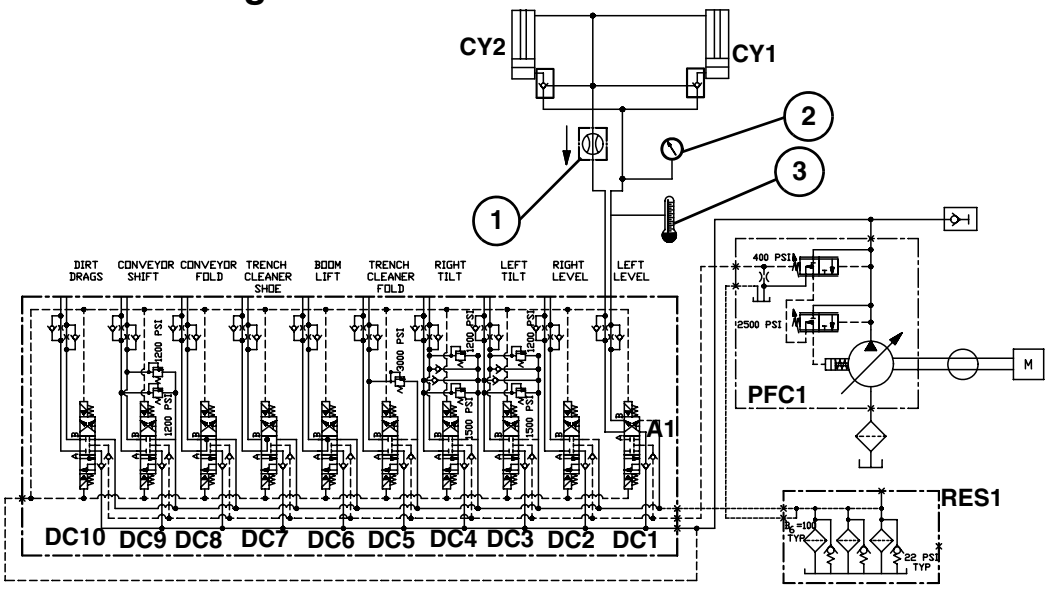
Test for an opens, shorts, and high resistance in the circuit. Refer to page **6B-13** and follow instructions for testing of left and right machine level circuits.

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WARNING: Pressurized fluid can penetrate body tissue and result in serious injury or death. Leaks can be invisible. Keep away from any suspected leak. Relieve pressure in the hydraulic system before searching for leaks, disconnecting hoses, or performing any other work on the system. If you must pressurize the system to find a suspected leak, use an object such as a piece of wood or cardboard rather than your hands. When loosening a fitting where some residual pressure may exist, slowly loosen the fitting until oil begins to leak. Wait for leaking to stop before disconnecting the fitting. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

Hydraulic Troubleshooting



The cylinders in the circuit perform the actual work and are most likely to be the component that fails in the circuit. Typical failures would include bending or breakage or leaking rod wiper seal. If an obvious problem is not found, the cylinders should be tested for excessive internal leakage.

NOTE: Ensure any hoses or fittings that are added to the test equipment are the same size and rating as hoses and fittings installed in the hydraulic circuit. Mismatched hose or fitting sizes can result in erroneous pressure indications. Mismatched pressure ratings can result in leakage or personal injury.

Cylinder Test Procedure

Some circuits have external lock valves as well as lock valve or counterbalance valve cartridge installed in the cylinder. If a cylinder will only work in one direction, it is possible that a lock valve or counterbalance valve cartridge may be faulty. If suspected, refer to the repair section and inspect, repair, or replace valves per instructions given.

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The following test will determine if cylinders are leaking beyond design specification. Some cylinders are plumbed together, if the test reveals excessive leakage, both cylinders should be inspected to determine if one or both are worn.

The illustrations depict cylinders being tested in the rod extend position. Damage to the test equipment can occur if it is not installed correctly. Note the direction of the arrow on the flow meter when installing.

When testing the rod retract position, install flow meter and pressure gauge to the opposite cylinder ports. The test procedure will be the same.

NOTE: Support the load with an adequate lifting device and ensure any residual pressure is released before installing test equipment.

1. Shut down engine.
2. Turn ground disconnect switch to DISABLE position.
3. Install flow meter **(1)** in series with connector of line feeding the rod end of cylinders.
4. Install pressure gauge **(2)** in parallel with the connector of line feeding the cap end of cylinders.
5. Make a photocopy of the cylinder test worksheet on page 6B-32.
6. Turn ground disconnect switch to the ENABLE position. Start the engine and inspect test equipment connections for leaks.
7. Allow system to warm to approximately 130°F (54°C). Observe pyrometer **(3)**.
8. Actuate directional control valve to the rod extend position.

   Expected result: When rod reaches the end of its stroke, the pressure in the cap (base) end of cylinder should increase to the value of the pump compensator setting, 2500 psi (172 bar). If the circuit being tested has cartridge relief valves, the pressure in the cap (base) end of cylinder should increase to the value of the relief setting. Refer to page 6A-12 for individual circuit relief settings.
9. While holding the position (deadheading cylinder), record on test worksheet:

- Pressure indicated on pressure gauge **(2)**.
- Flow indicated on flow meter **(1)**.

10. Release directional control valve.
11. Shut down engine and analyze test results. Refer to analyzing cylinder test results on page 6B-17.

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12. At conclusion of test procedure, remove test equipment, reconnect hydraulic lines, and tighten connections securely.

13. Start engine and check connections for leaks.

Analyzing Cylinder Test Results

NOTE: Some cylinder circuits operate at higher pressures and flows than others. Circuits operating at lower than maximum pump compensator setting may operate normally, while circuits requiring higher pressure and flow may not. If the pump compensator or a cartridge valve relief pressure cannot be obtained, it may indicate a problem with the pump or control valve section. If suspected, refer to shared hydraulic components test procedures.

Diagnostic Observation 1:

- Pressure gauge **(2)** indicates pump compensator setting or the cartridge relief valve setting if installed in control valve section.
- Flow meter **(1)** indicates zero to marginal flow.

Diagnosis - Leakage across the piston appears to be within design specification.

Diagnostic Observation 2:

- Pressure gauge **(2)** indicates pump compensator setting or the cartridge relief valve setting if installed in control valve section.
- Flow meter **(1)** indicates moderate to high flow.

Diagnosis - Leakage across the piston appears to be excessive. Repair or replace cylinder.

Diagnostic Observation 3:

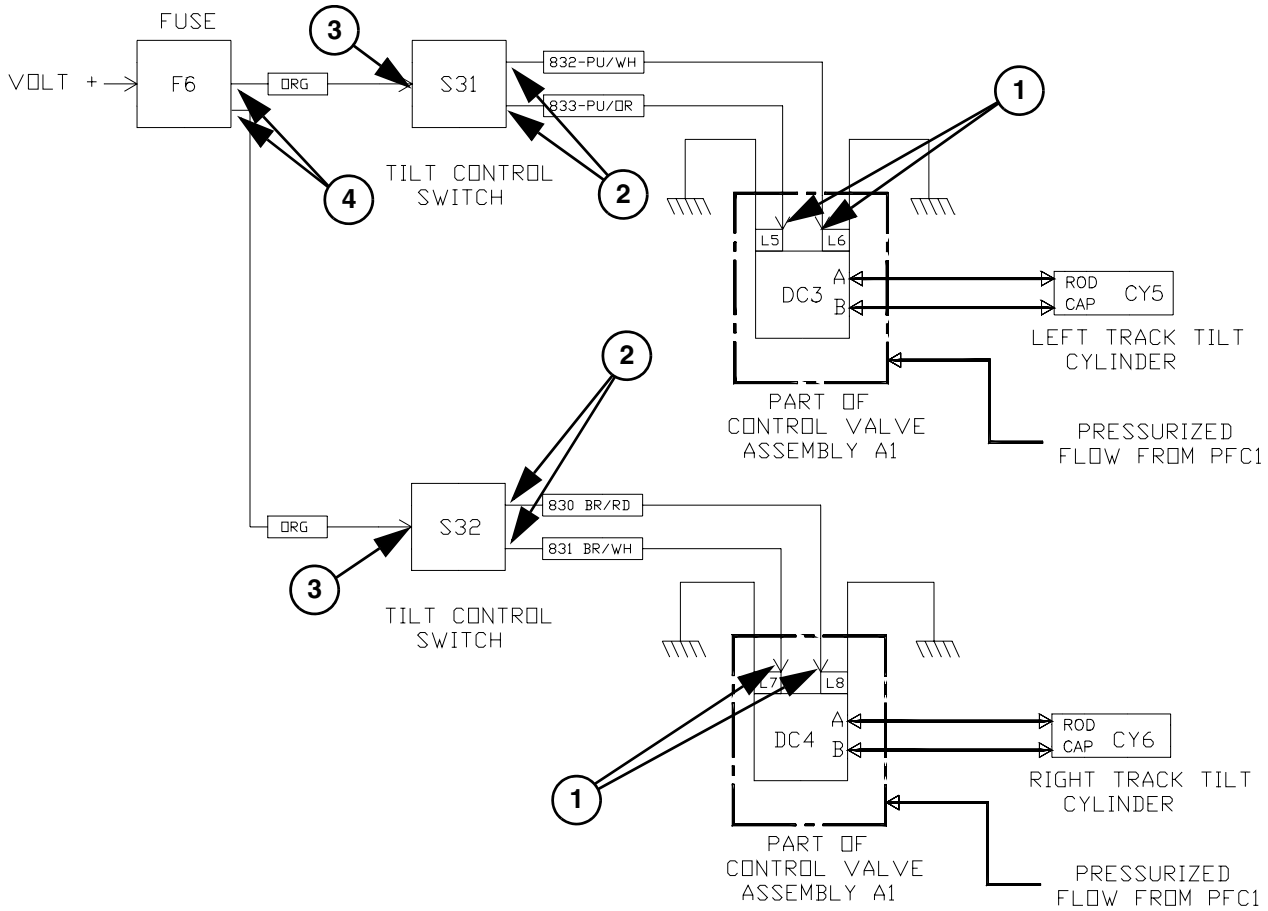
- Pressure gauge **(2)** indicates a pressure somewhat less than pump compensator setting or the cartridge relief valve setting if installed in control valve section.
- Flow meter **(1)** indicates high flow.

Diagnosis - Leakage across the piston is excessive. Repair or replace cylinder.

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LEFT AND RIGHT TRACK TILT CIRCUITS

Electrical Troubleshooting



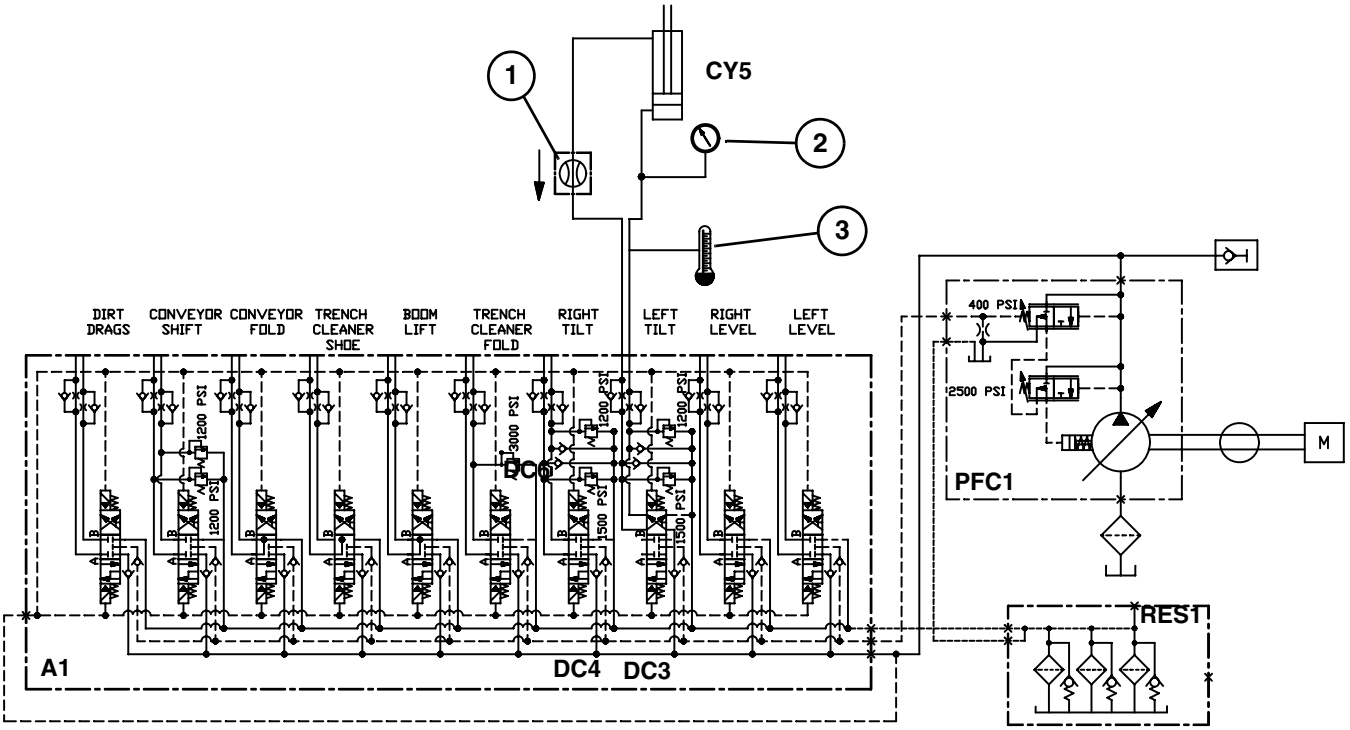
Refer to the reference diagrams and electrical troubleshooting procedures for machine level circuits on page **6B-10**. The procedures for testing the track tilt function electrical circuits are the same. The procedures test for opens, shorts, or high resistance in the circuits.

Testing Sequence

The testing sequence gives a troubleshooter a logical place to begin troubleshooting the electrical circuit inputs and outputs. The sequence test points start at the load **(1)** and work back through the complete circuit **(4)**.

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Hydraulic Troubleshooting



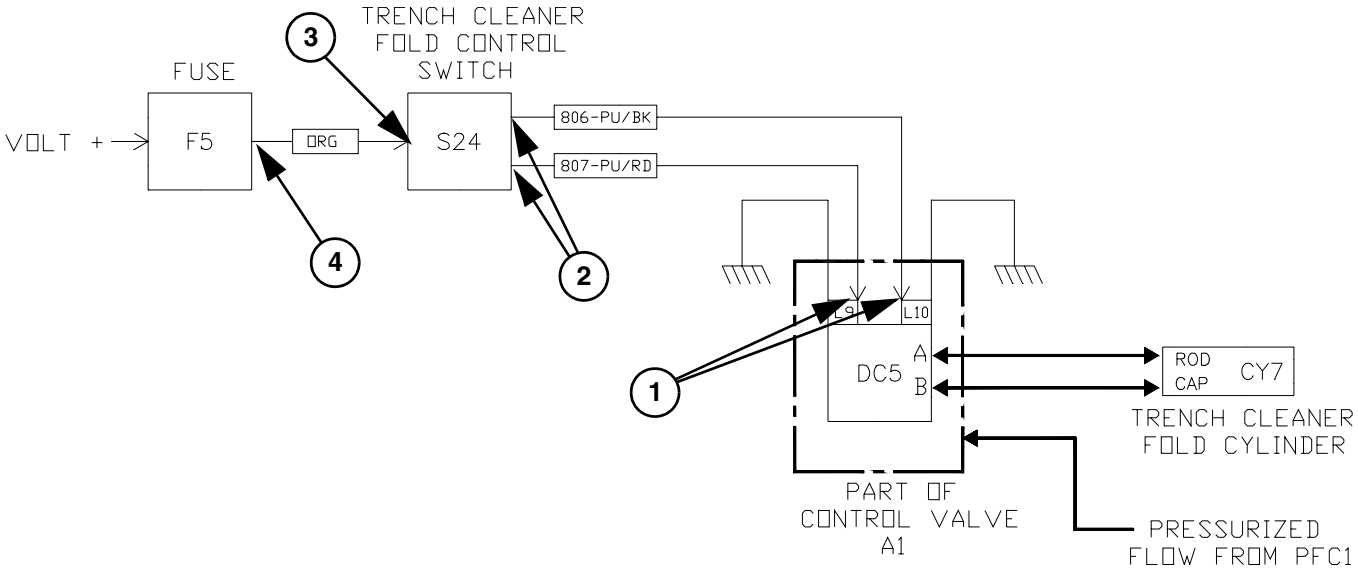
The cylinders in the circuit perform the actual work and are most likely to be the component that fails in the circuit. Typical failures would include bending or breakage or leaking rod wiper seal. If an obvious problem is not found, the cylinders should be tested for excessive internal leakage.

Install the test equipment as shown in above diagram. Refer to page **6B-15** and follow cylinder test procedures.

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TRENCH CLEANER FOLD CIRCUIT

Electrical Troubleshooting



Refer to the reference diagrams and electrical troubleshooting procedures for machine level circuits on page **6B-10**. The procedures for testing the trench cleaner fold function electrical circuit is the same. The procedures test for opens, shorts, or high resistance in the circuits.

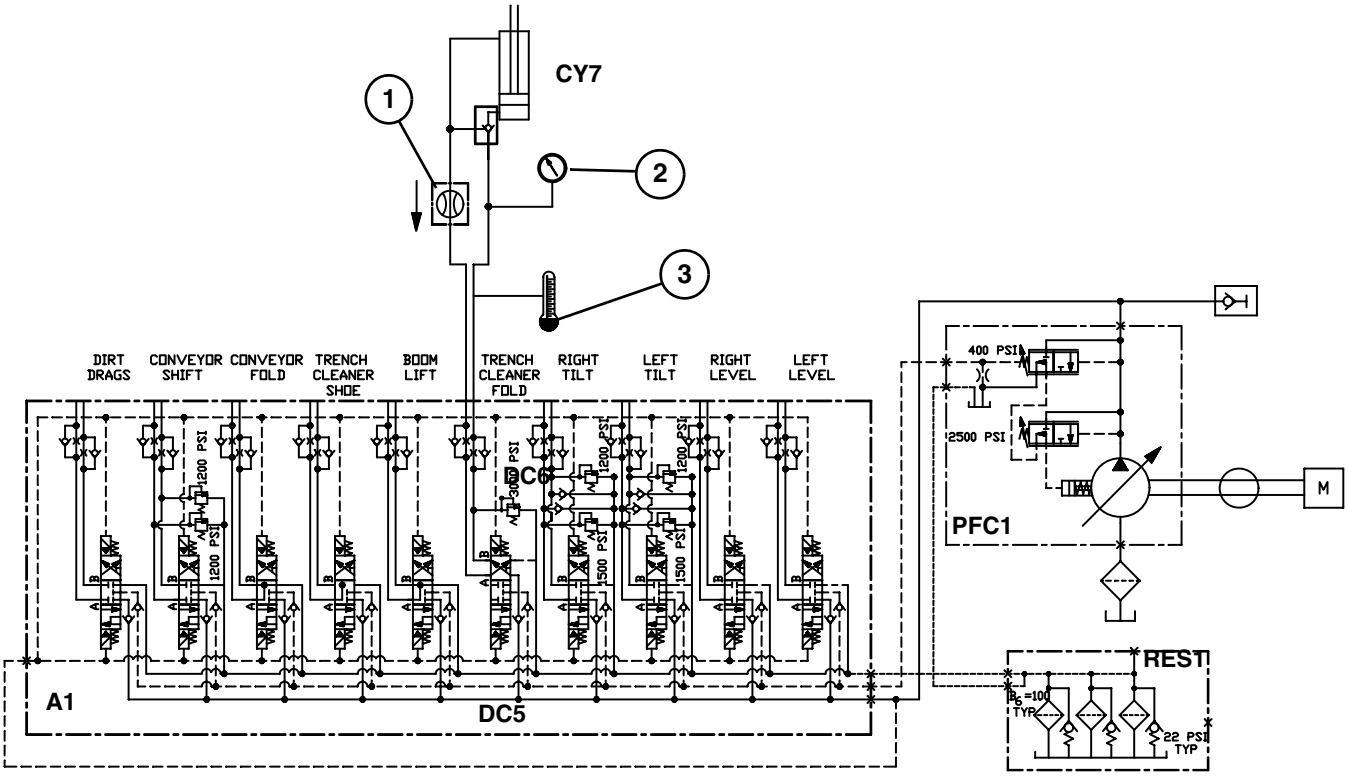
Testing Sequence

The testing sequence gives a troubleshooter a logical place to begin troubleshooting the electrical circuit inputs and outputs. The sequence test points start at the load **(1)** and work back through the complete circuit **(4)**.

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Hydraulic Troubleshooting



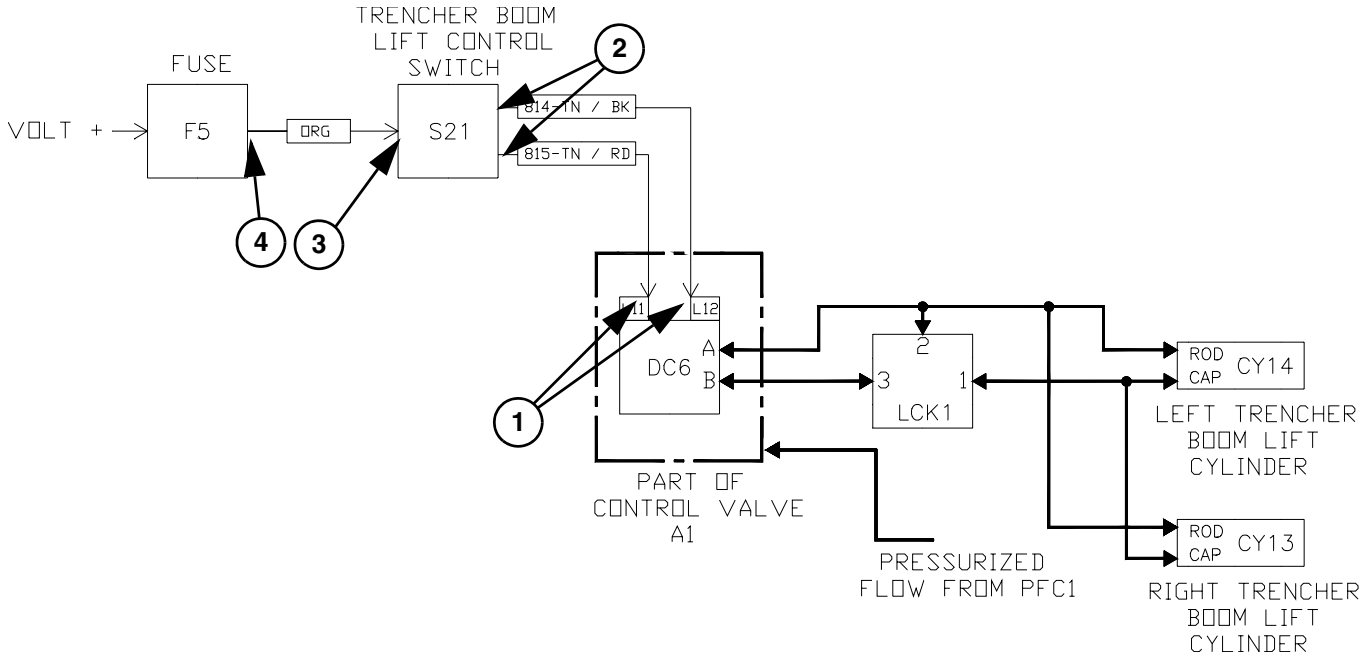
The cylinder in the circuit performs the actual work and is most likely to be the component that fails in the circuit. Typical failures would include bending or breakage or leaking rod wiper seal. If an obvious problem is not found, the cylinders should be tested for excessive internal leakage.

Install the test equipment as shown in above diagram. Refer to page **6B-15** and follow cylinder test procedures.

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TRENCHER BOOM LIFT CIRCUIT

Electrical Troubleshooting



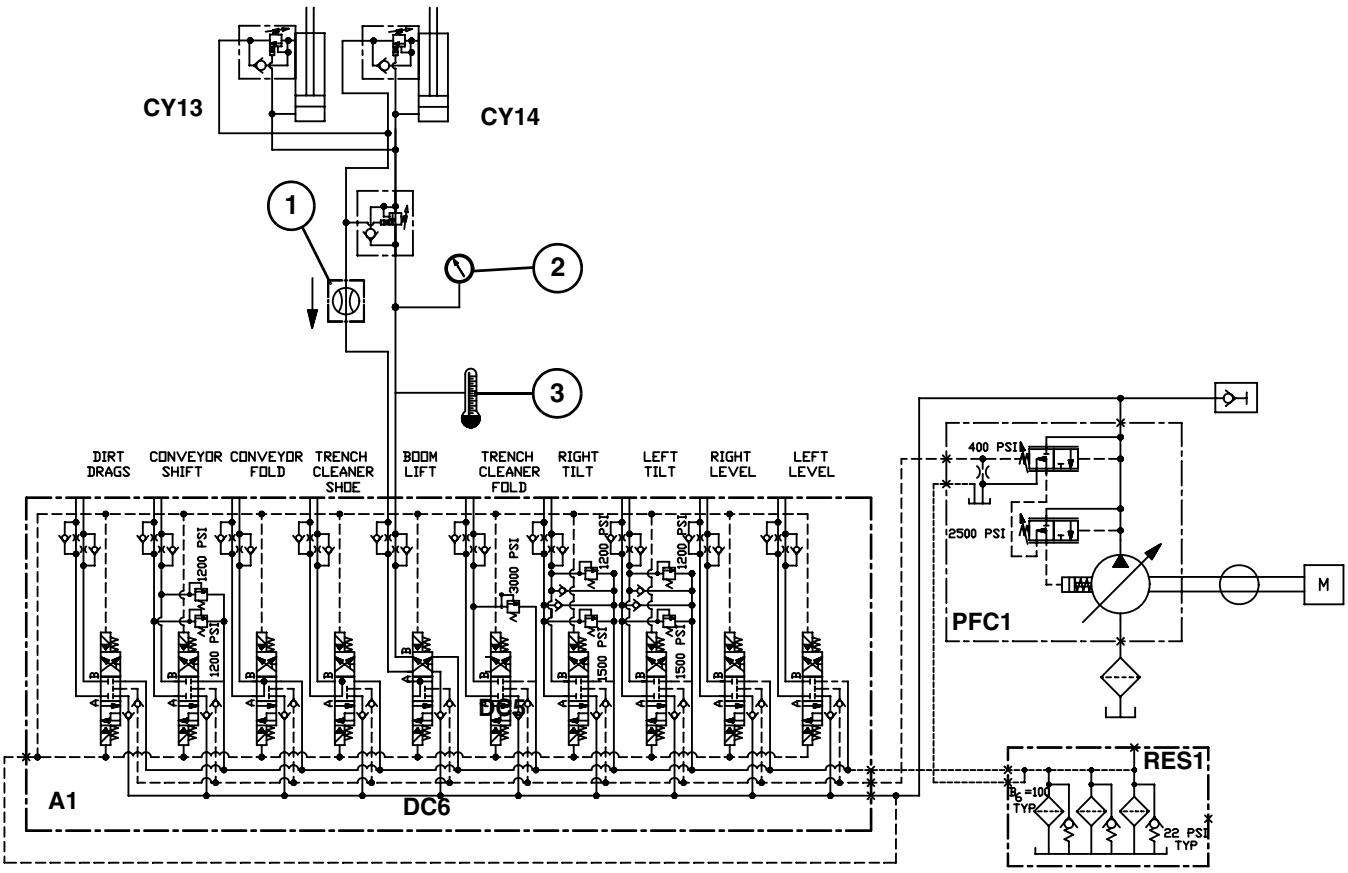
Refer to the reference diagrams and electrical troubleshooting procedures for machine level circuits on page 6B-10. The procedures for testing the trencher boom lift function electrical circuits are the same. The procedures test for opens, shorts, or high resistance in the circuits.

Testing Sequence

The testing sequence gives a troubleshooter a logical place to begin troubleshooting the electrical circuit inputs and outputs. The sequence test points start at the load **(1)** and work back through the complete circuit **(4)**.

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Hydraulic Troubleshooting



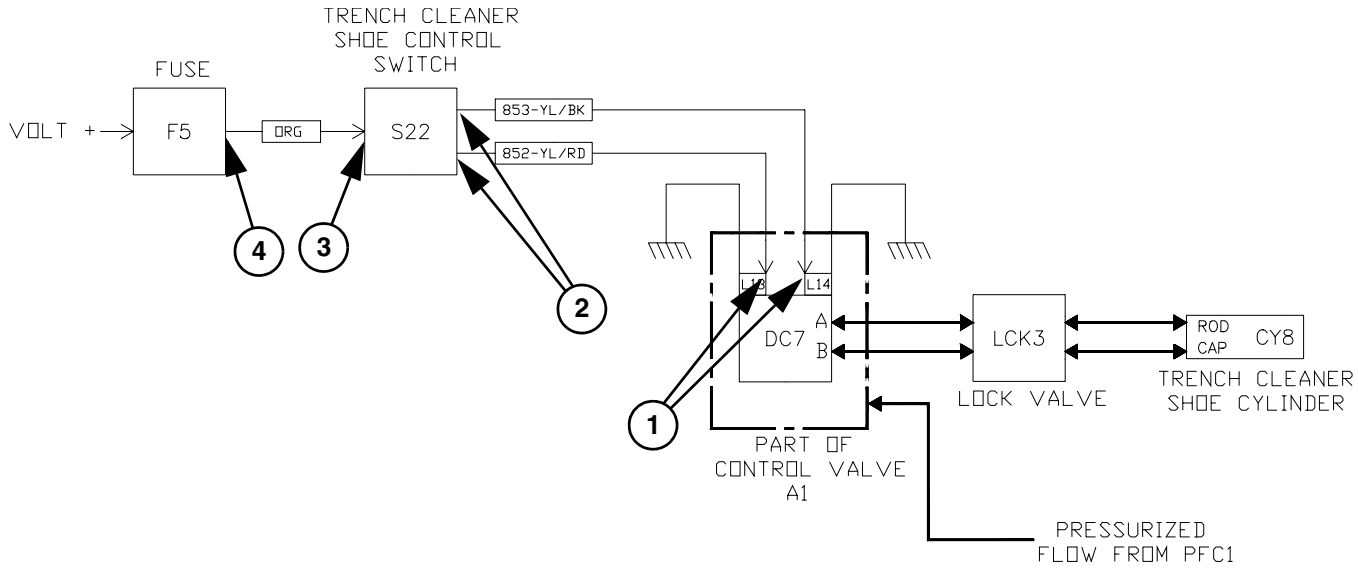
The cylinders in the circuit perform the actual work and are most likely to be the component that fails in the circuit. Typical failures would include bending or breakage or leaking rod wiper seal. If an obvious problem is not found, the cylinders should be tested for excessive internal leakage.

Install the test equipment as shown in above diagram. Refer to page **6B-15** and follow cylinder test procedures.

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TRENCH CLEANER SHOE CIRCUIT

Electrical Troubleshooting



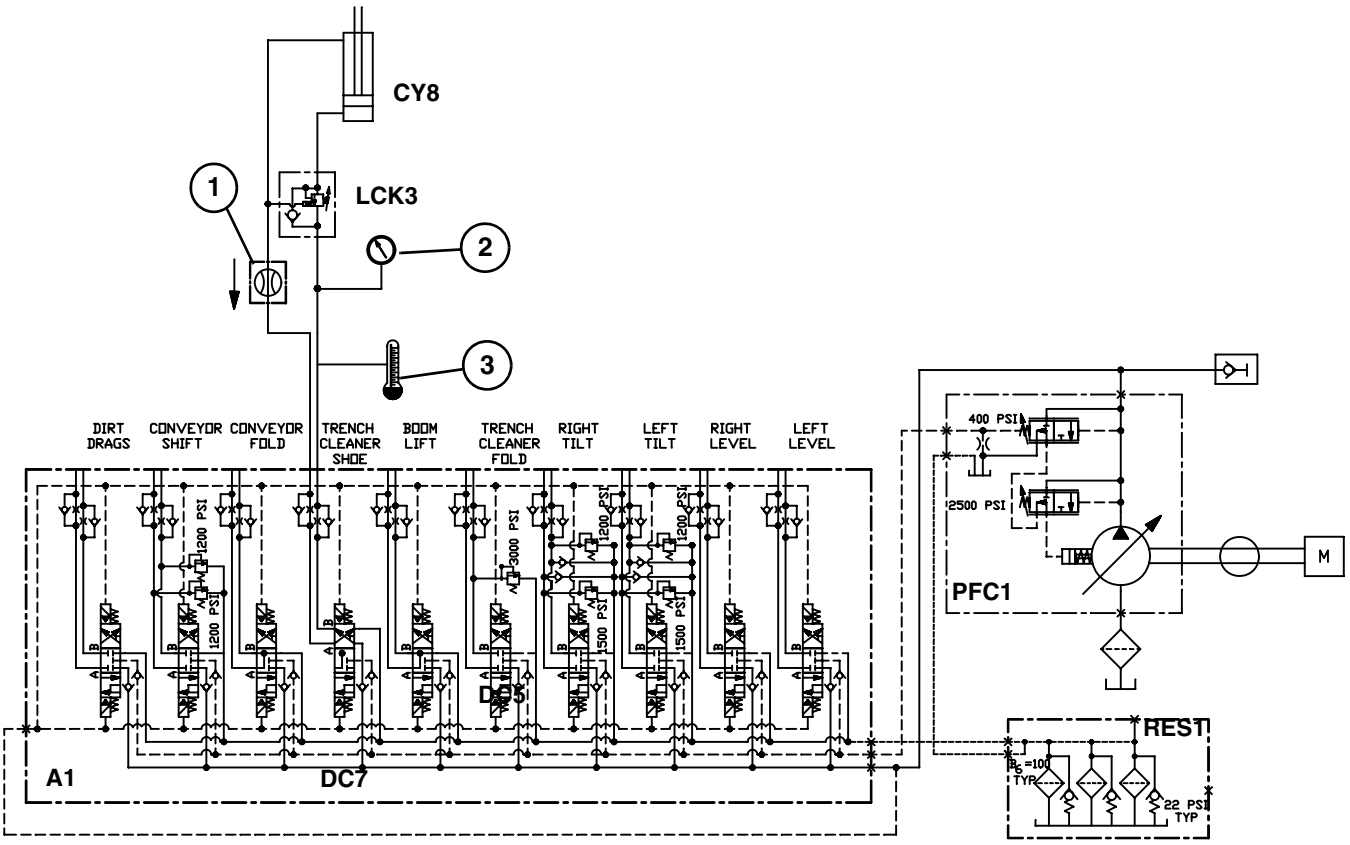
Refer to the reference diagrams and electrical troubleshooting procedures for machine level circuits on page 6B-10. The procedures for testing the trench cleaner shoe function electrical circuit is the same. The procedures test for opens, shorts, or high resistance in the circuits.

Testing Sequence

The testing sequence gives a troubleshooter a logical place to begin troubleshooting the electrical circuit inputs and outputs. The sequence test points start at the load **(1)** and work back through the complete circuit **(4)**.

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Hydraulic Troubleshooting



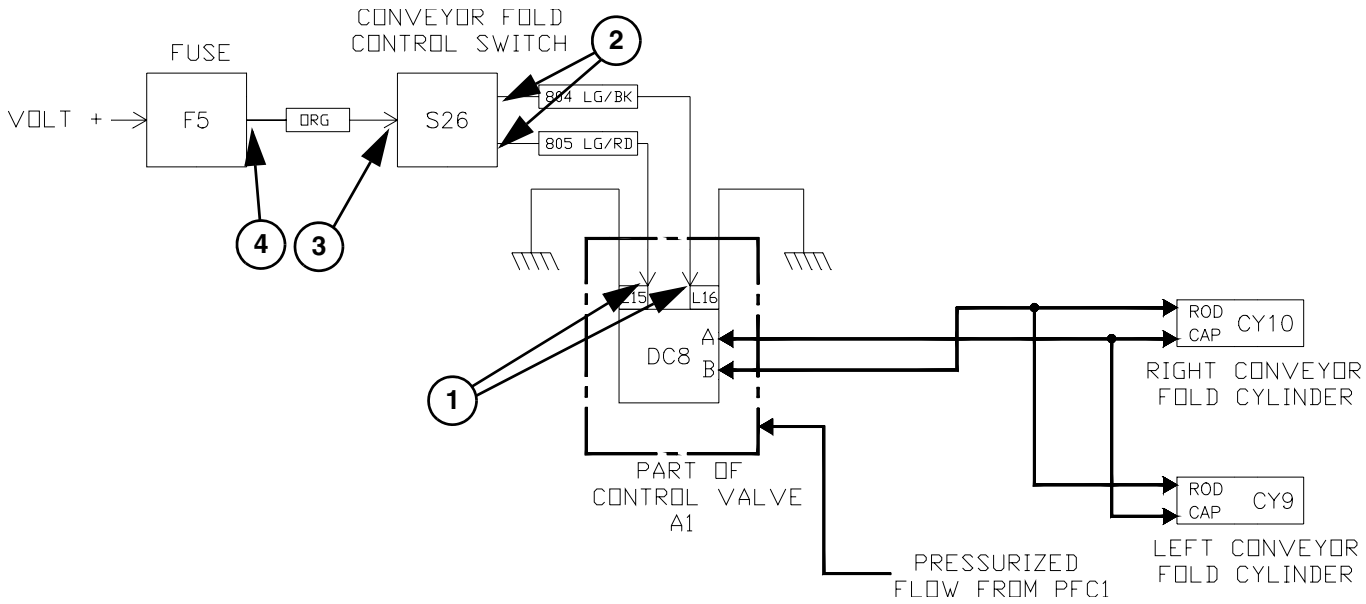
The cylinder in the circuit performs the actual work and is most likely to be the component that fails in the circuit. Typical failures would include bending or breakage or leaking rod wiper seal. If an obvious problem is not found, the cylinders should be tested for excessive internal leakage.

Install the test equipment as shown in above diagram. Refer to page **6B-15** ad follow cylinder test procedures.

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CONVEYOR FOLD CIRCUIT

Electrical Troubleshooting



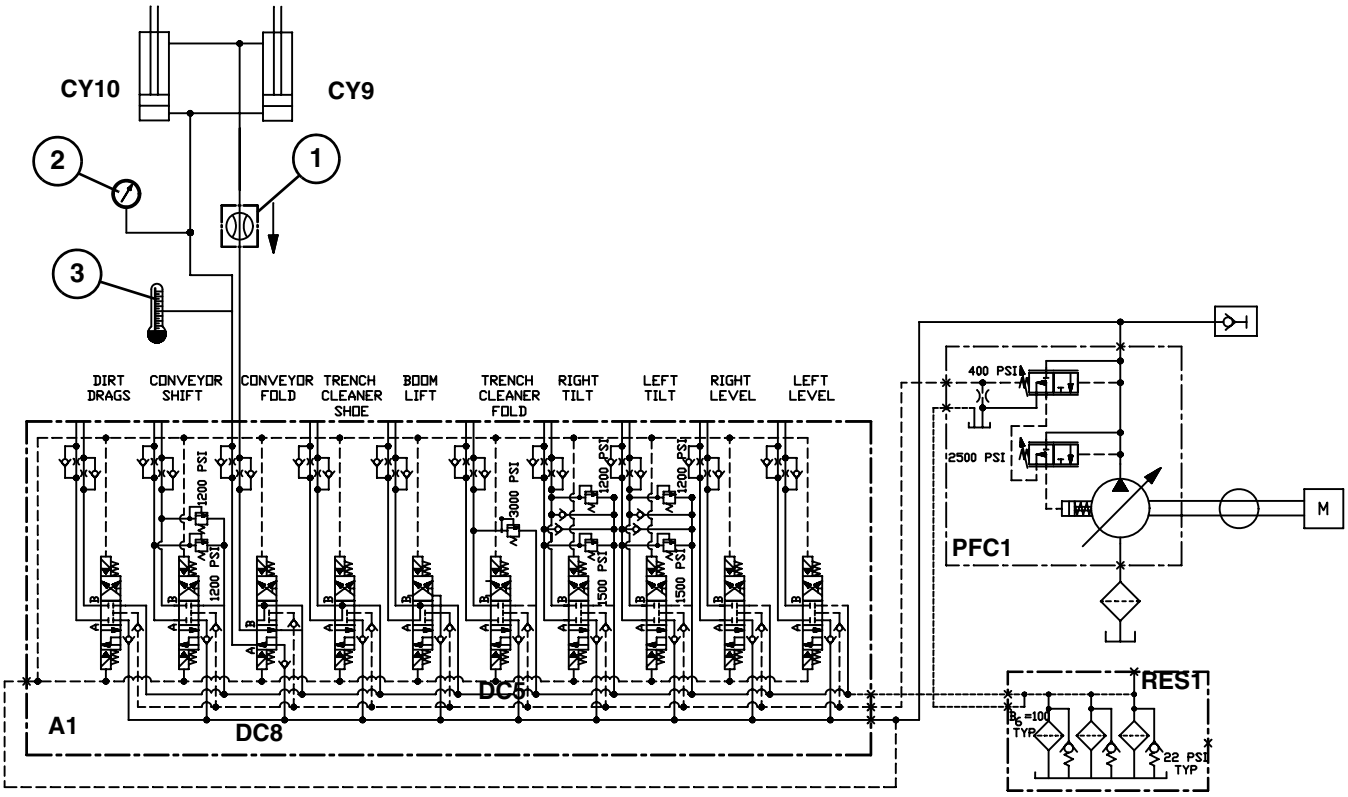
Refer to the reference diagrams and electrical troubleshooting procedures for machine level circuits on page 6B-10. The procedures for testing the conveyor fold function electrical circuits are the same. The procedures test for opens, shorts, or high resistance in the circuits.

Testing Sequence

The testing sequence gives a troubleshooter a logical place to begin troubleshooting the electrical circuit inputs and outputs. The sequence test points start at the load **(1)** and work back through the complete circuit **(4)**.

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Hydraulic Troubleshooting



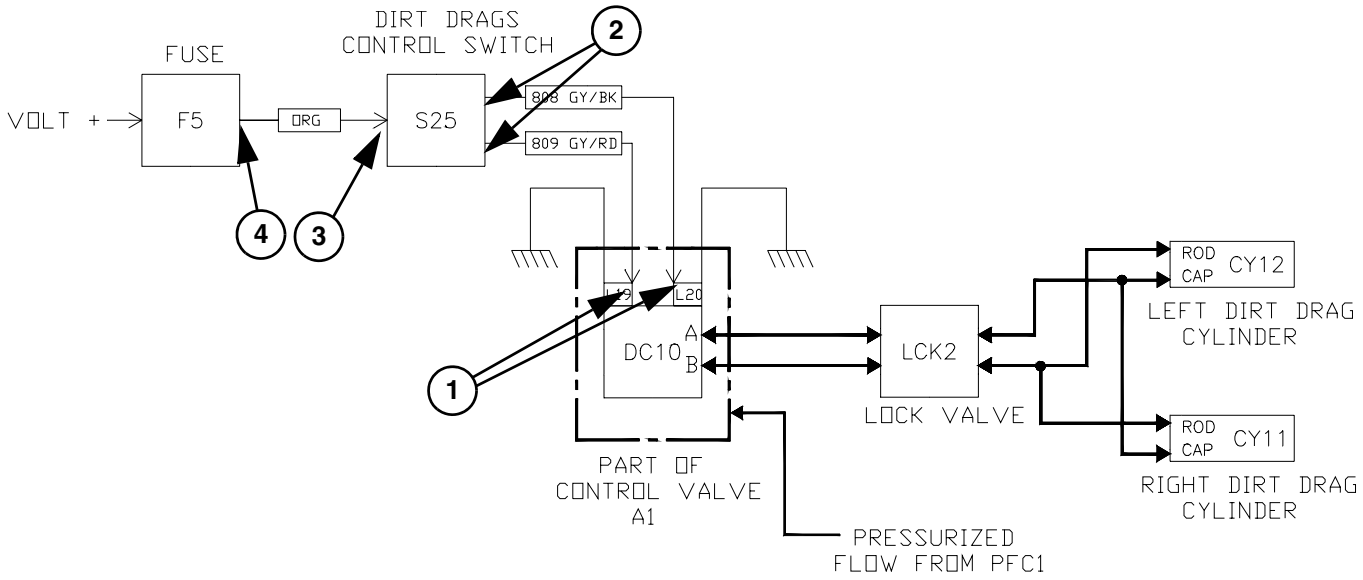
The cylinders in the circuit perform the actual work and are most likely to be the component that fails in the circuit. Typical failures would include bending or breakage or leaking rod wiper seal. If an obvious problem is not found, the cylinders should be tested for excessive internal leakage.

Install the test equipment as shown in above diagram. Refer to page **6B-15** and follow cylinder test procedures.

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DIRT DRAGS CIRCUIT

Electrical Troubleshooting



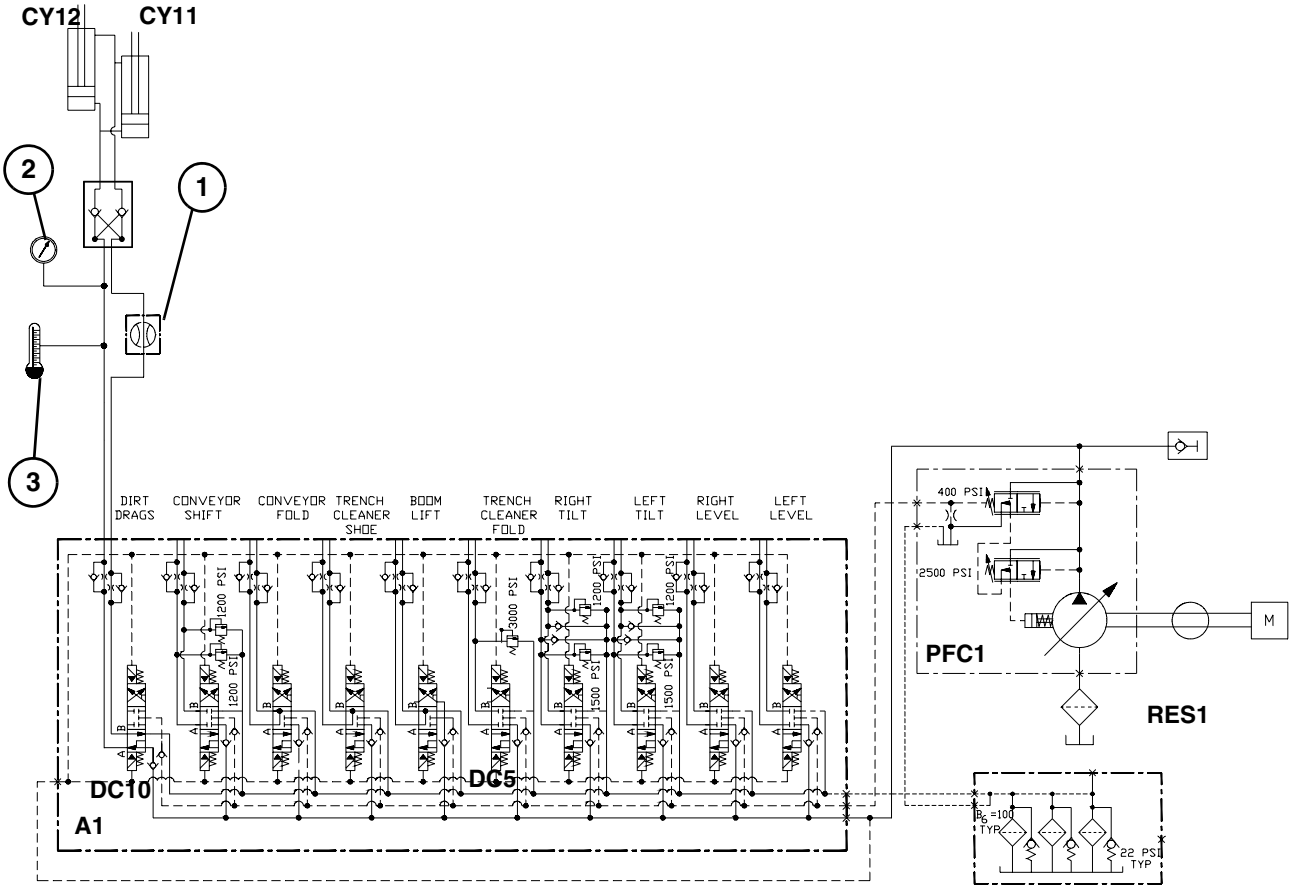
Refer to the reference diagrams and electrical troubleshooting procedures for machine level circuits on page 6B-10. The procedures for testing the dirt drags function electrical circuits are the same. The procedures test for opens, shorts, or high resistance in the circuits.

Testing Sequence

The testing sequence gives a troubleshooter a logical place to begin troubleshooting the electrical circuit inputs and outputs. The sequence test points start at the load **(1)** and work back through the complete circuit **(4)**.

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Hydraulic Troubleshooting



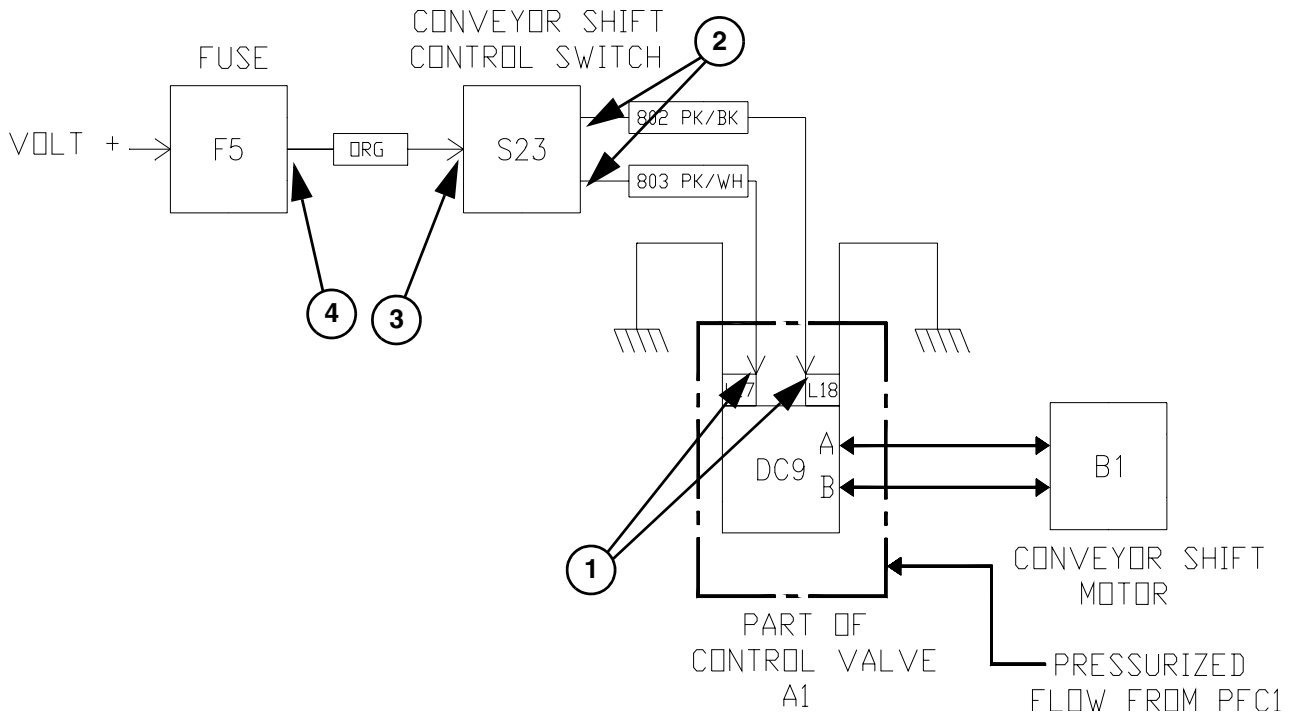
The cylinders in the circuit perform the actual work and are most likely to be the component that fails in the circuit. Typical failures would include bending or breakage or leaking rod wiper seal. If an obvious problem is not found, the cylinders should be tested for excessive internal leakage.

Install the test equipment as shown in above diagram. Refer to page **6B-15** and follow cylinder test procedures.

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CONVEYOR SHIFT CIRCUIT

Electrical Troubleshooting



Refer to the reference diagrams and electrical troubleshooting procedures for machine level circuits on page 6B-10. The procedures for testing the conveyor shift function electrical circuits are the same. The procedures test for opens, shorts, or high resistance in the circuits.

Testing Sequence

The testing sequence gives a troubleshooter a logical place to begin troubleshooting the electrical circuit inputs and outputs. The sequence test points start at the load **(1)** and work back through the complete circuit **(4)**.

Hydraulic Troubleshooting

The motor in the circuit performs the actual work. This would normally be the first part of the circuit to troubleshoot if the conveyor is moving slower than normal. If the pump were suspect, other circuits would be affected and the pump would be tested first. Testing the motor for excessive leakage can be quite labor intensive. Compared to the price of a new motor it is not cost effective.

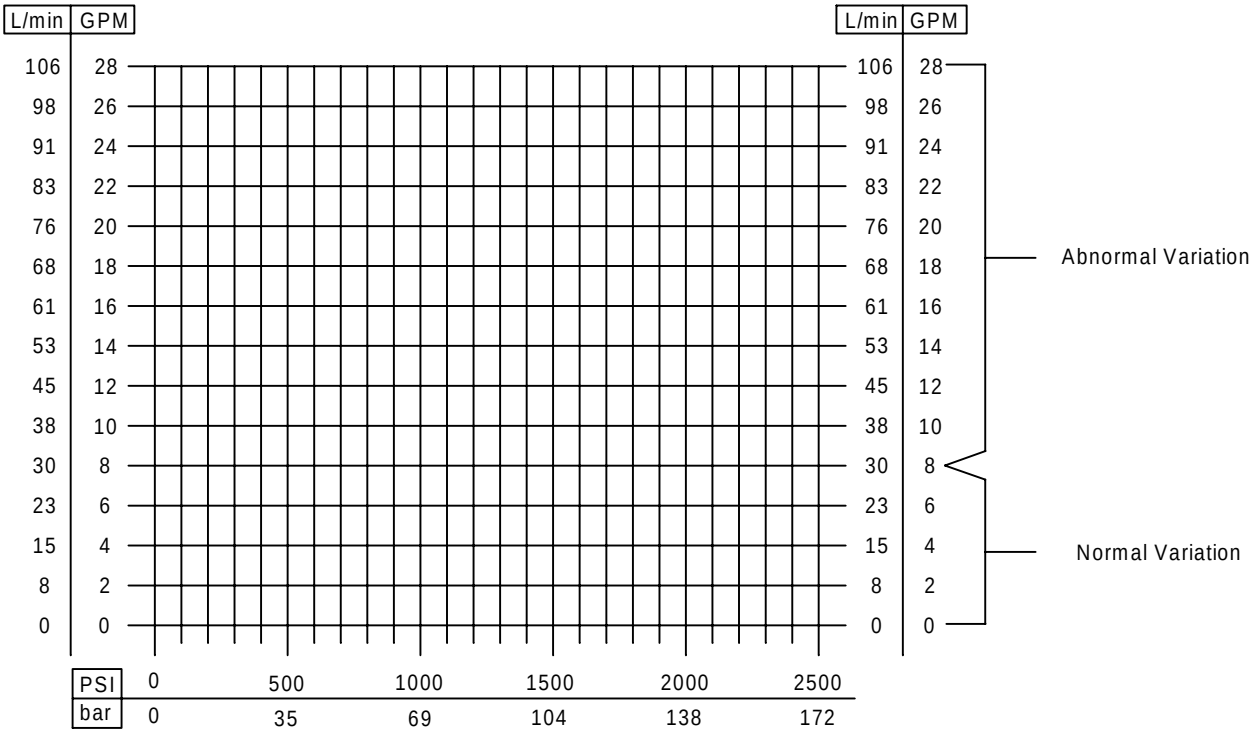
Therefore, the hydraulic testing for this circuit should begin with an inspection of the valve section relief valves PRL1 & PRL2 and directional control valve section DC9 for excessive leakage. Refer to the procedures in the implement repair section beginning on page 6C-5. If the valve section and relief valves are OK, replace the conveyor shift motor.

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PUMP WORKSHEET

Specifications and Tolerances

Engine Speed Set @ 2350 rpm
Pump displacement: 2.77 cid (45 cc)
Tested to 2500 PSI (172 bar)
Pump Inlet Restriction: 3" Hg (76.2 mm) Continuous Max.
Nominal Case Drain Flow 2 gpm (7.5 L/min)
Maximum Case Drain Flow 8 gpm (30 L/min)



Engine No-Load Speed _____ RPM

Engine Full-Load Speed _____ RPM

Ambient Temp. _____ °F/°C

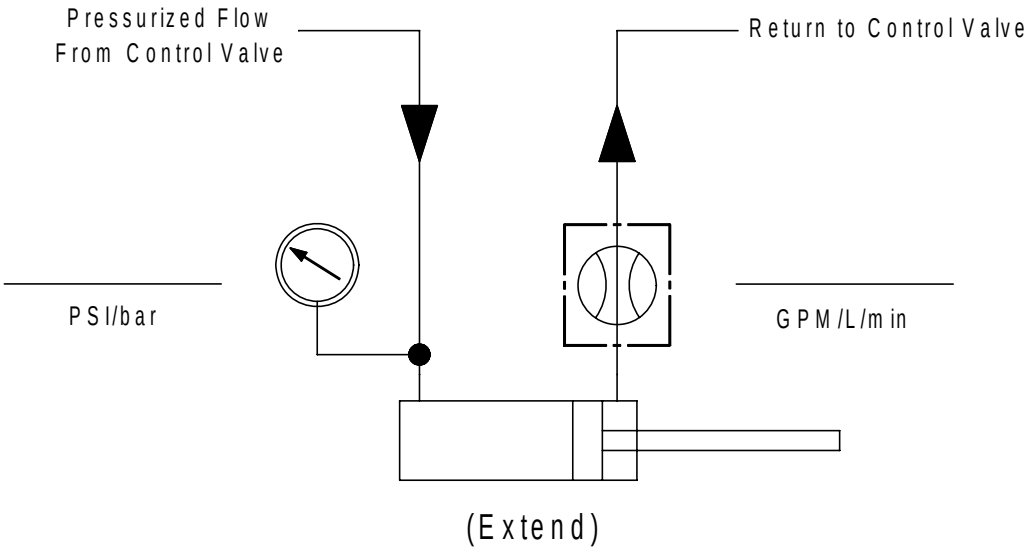
System Temp. _____ °F/°C

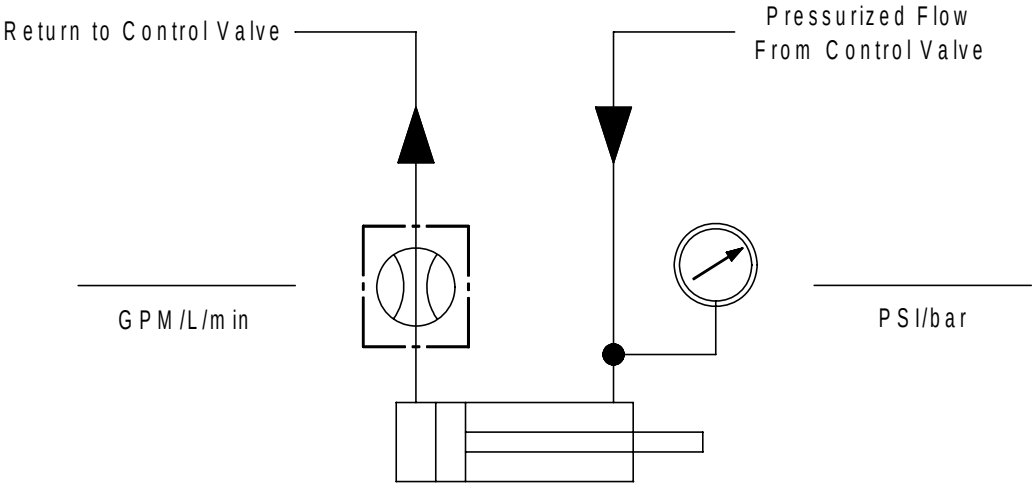
Inlet Restriction _____ in/mm Hg

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CYLINDER WORKSHEET

Cylinder Seal/Bore Deadhead Extend/Retract Test Procedure





°F/°C
Ambient Temp.

°F/°C
System Temp.

Chapter 6: Implement Subsystem

Section C: Repair

INTRODUCTION

This section consists of repair procedures including the removal, replacement, installation, repair, and adjustments of those hydraulic components responsible for the operation of the implement circuits.

Components

Hydraulic:

- Pump PFC1
- Directional Control Valve Assembly A1
- Cylinders CY1–CY14
- Conveyor Shift Motor B1

HYDRAULIC REPAIR

Cleanliness is extremely important when replacing or repairing hydraulic components. Work in a clean area. Before disconnecting hoses, thoroughly clean the port areas of pump, valve, cylinders and motors to be removed. Thoroughly clean outside of each component to be reinstalled.



WARNING: Pressurized fluid can penetrate body tissue and result in serious injury or death. Leaks can be invisible. Relieve pressure in the hydraulic system before disconnecting hoses or performing work on the system. When searching for a leak, use a piece of cardboard rather than your hands. When loosening fittings where residual pressure may exist, slowly loosen the fitting until oil begins to leak. Wait for leaking to stop before disconnecting the fitting. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

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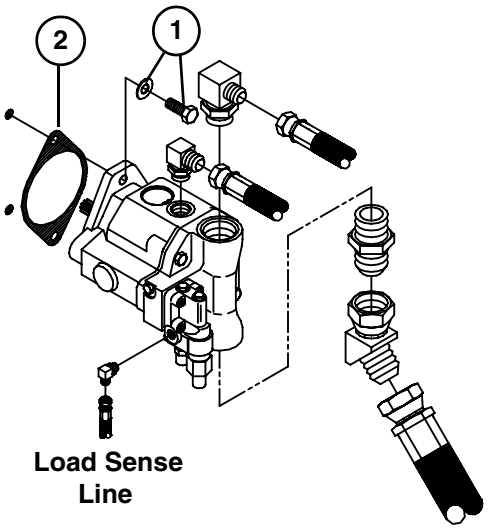
Pump PFC1

The implement pump can be replaced as a complete unit or repaired by replacing the shaft seals and/or pressure-flow compensator assembly.

Remove

To remove pump:

1. Follow *"Shutdown Procedure," page* **2-1**.
2. Label and disconnect each hose from pump. Cap all fittings and plug all hoses.
3. Remove bolts and washers **(1)** securing pump to engine. Remove pump.
4. Remove and discard old gasket **(2)**. Ensure all of the old gasket is removed from pump mounting area of engine.



Install

Reverse the removal procedure to install new pump.

- Remove fittings from old pump and install in the same orientation to the new pump.
- Apply Molykote G-N paste to spline shaft of pump.
- Install new gasket **(2)**.
- Torque bolts **(1)** according to standard torque charts.
- Perform the start-up procedure. Refer to page **6C-4**.

Pump Shaft Seal

A replacement shaft seal is available for repairing the pump.

Replace

To replace seal:

1. Refer to previous page and follow instructions for removing pump.
2. Remove internal retaining ring securing the shaft seal in place.
3. Remove old seal and insure area around shaft is clean. Install new seal.
4. Install pump per instructions above.

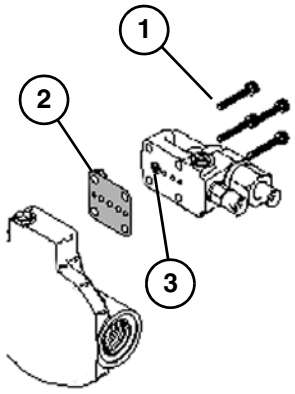
Pump Pressure-Flow Compensator Assembly

If the pressure-flow compensator has failed and will not adjust, it can be replaced as a complete unit.

Replace

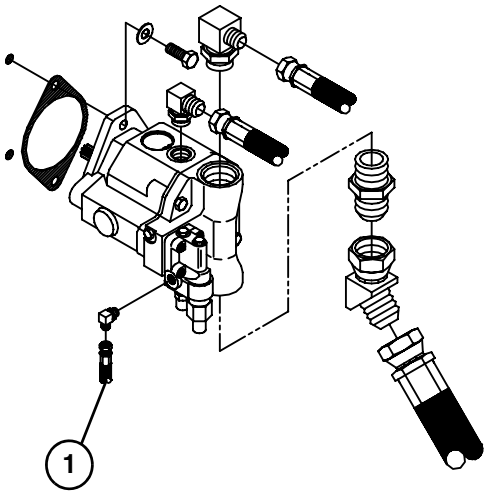
To replace unit:

1. Refer to previous page and follow instructions for removing pump.
2. Remove four cap screws **(1)**.
3. Remove and discard existing gasket **(2)** and O-ring **(3)**. Ensure all of the old gasket is removed from compensator assembly and pump.
4. Install new gasket **(2)** and O-ring **(3)**.
5. Install new compensator assembly using four cap screws **(1)** and torque 10–12 ft-lb (14–16 Nm)
6. Install pump per instructions above.
7. Perform the start-up procedure. Refer to page 6C-4.



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Pump Start-Up Procedure



1. After installing pump and connecting and tightening all fittings and hoses, fill pump case at least half full with oil that has been filtered through a 10-micron filter.
2. Ensure oil tank is full of oil. If not, fill with oil that has been filtered through a 10-micron filter. Leave fill cap loose so any trapped air will escape.
3. Turn off fuel flow to the engine fuel injectors and turn the engine over for 15 seconds. This will allow the pump to pick up the oil before start-up.
4. Disconnect load sense line **(1)** from the pump compensator and energize one of the control valve functions while the engine is turning over. This will allow oil to flow through the load sense line, thus, removing any air in the line.
5. Reconnect load sense line when a steady flow of oil is coming from the line.
6. Turn fuel flow back on to fuel injectors and start the engine. Run at low idle speed for one minute. The pump should immediately pick up oil and go into low pressure standby.
7. After pump has stabilized in low pressure standby, operate the implement functions to purge the system of air and to fill the cylinders with oil. Continue operating the system slowly with no load until it responds fully.
8. Check oil level in tank and refill if necessary to proper level with oil that has been filtered through a 10-micron filter.
9. Check all connections for leaks tighten if necessary.

Directional Control Valve Assembly A1

Complete valve sections can be replaced or repaired with seal kits. The port relief valves and solenoid coil cartridges can also be replaced or repaired. When installing new valve section and/or spool seal kits it is easier to remove the entire valve assembly from the machine. The valve can then be placed on a workbench for easy access.

NOTE: The valve sections and spools are matched. If a valve spool is damaged, replace entire section assembly.

NOTE: Because of the extent of work involved when disassembling the control valve, it may be a good idea to replace all the valve seals when repairing a leaking section or spool.

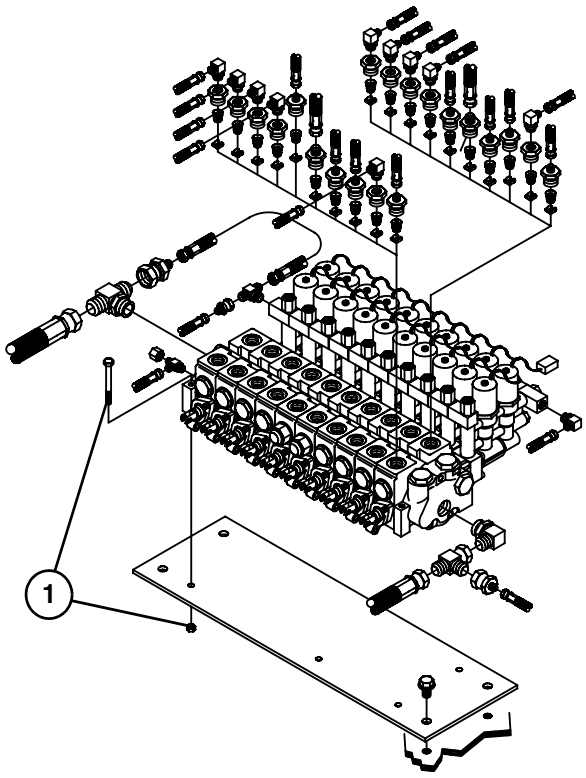
Remove

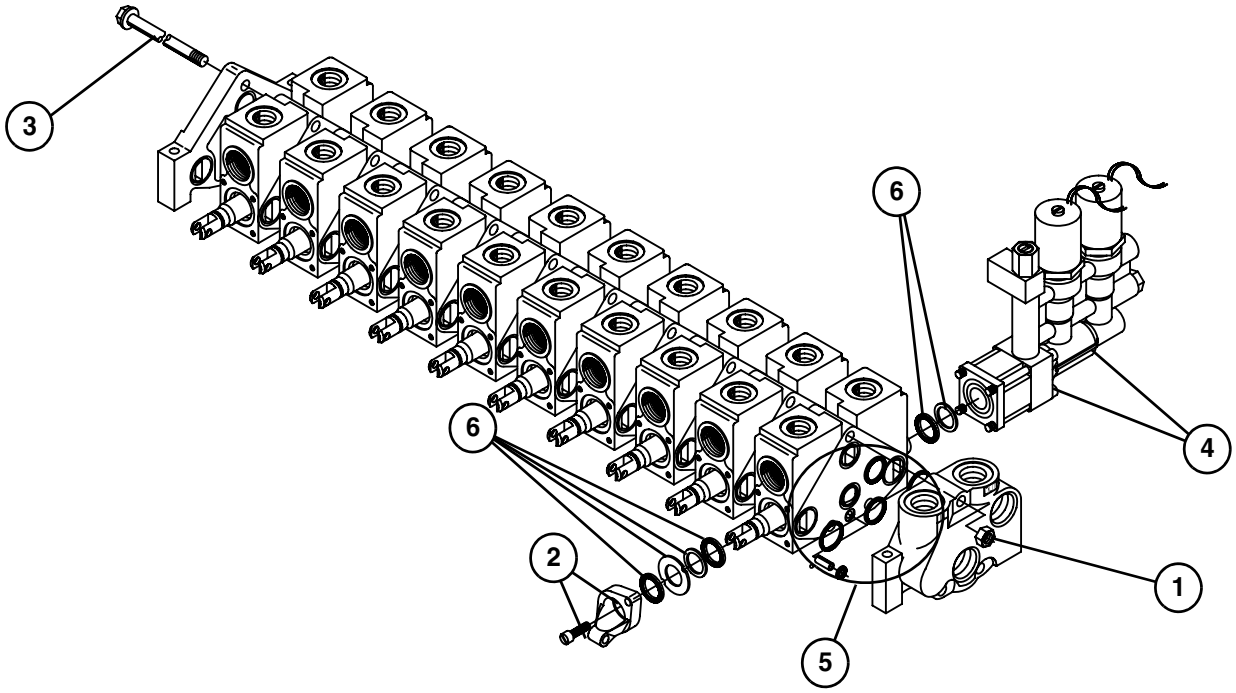
To remove valve assembly:

1. Follow *"Shutdown Procedure," page* **2-1**.
2. Label each hose and the function it serves. This will make it easier when reinstalling valve. Remove all hydraulic hoses. Cap all fittings and plug all hoses.

NOTE: The valve assembly is very heavy. Use a suitable lifting device when removing.

3. Remove three bolts and nuts **(1)** securing valve to machine.
4. Lift valve and place it on workbench.





Valve Section Seals

Replace

To replace valve section seals:

NOTE: Before disassembly, it is suggested that each valve section be marked numerically to avoid incorrect reassembly.

1. Remove stud kit nuts **(1)** connecting the valve sections together.
2. Remove valve sections by sliding from assembly studs **(3)**, note orientation of the backup washers and O-rings. This will ensure new seals will be installed correctly.
3. Remove old seals **(5)**. Thoroughly clean O-ring counterbores and ground surfaces of each section.
4. Install new seals in order old ones were removed.
5. Replace valve sections on assembly studs in the same order they were removed. Use care to avoid dislodging O-rings from counterbores.
6. Reinstall stud nuts and torque to 32 ft-lb (43 Nm).

Valve Spool Seals

Replace

To replace spool seals:

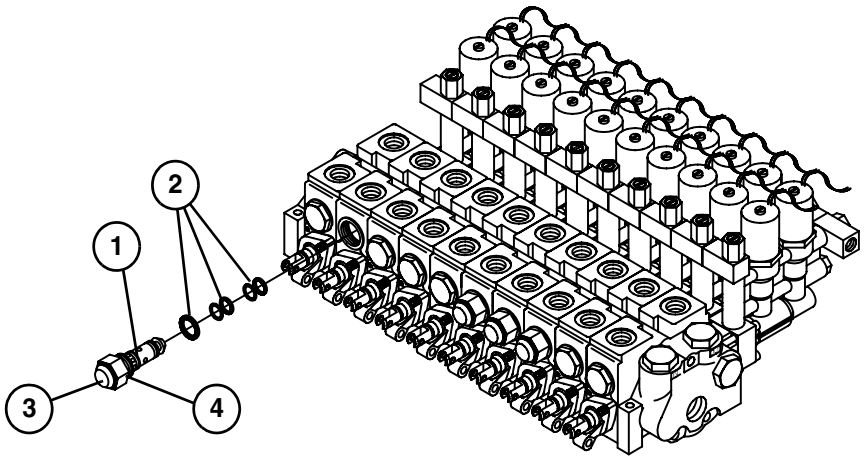
1. Remove bracket **(2)**, actuator assembly **(4)**, and associated mounting hardware. Note orientation of the backup washers and O-rings. This will ensure new seals will be installed correctly.

NOTE: Do not remove spools as the seals can be replaced externally. Prevent spools from turning or moving by inserting screw driver through the clevis slot. Do not hold spool with a wrench. That will destroy the finish.

2. Remove old seals **(6)** and thoroughly clean O-ring counterbores of each section.
3. Lightly oil new seals. Slide over valve spools and insert in seal counterbores.

Valve Section Relief Valves

The relief valve cartridges can be replaced as a complete unit or repaired by replacing seals and or poppet spool.



Seals - Replace

To replace seals in a relief valve cartridge:

1. Remove cartridge **(1)** to be repaired from the valve section.
2. Remove old seals **(2)**. Note orientation of the backup washers and O-rings. This will ensure new seals will be installed correctly.
3. Install new seals in order old ones were removed.
4. Install relief cartridge into valve and torque hex **(4)** to 20 ft-lb (27 Nm).

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Poppet / Piston Ring - Replace

To replace relief poppet and piston ring:

1. Remove relief cap **(3)**. The poppet and piston ring (not shown) are inside.
2. Remove poppet and piston ring and replace with new ones.
3. Install cap **(3)** and torque to 14 ft-lb (19 Nm).

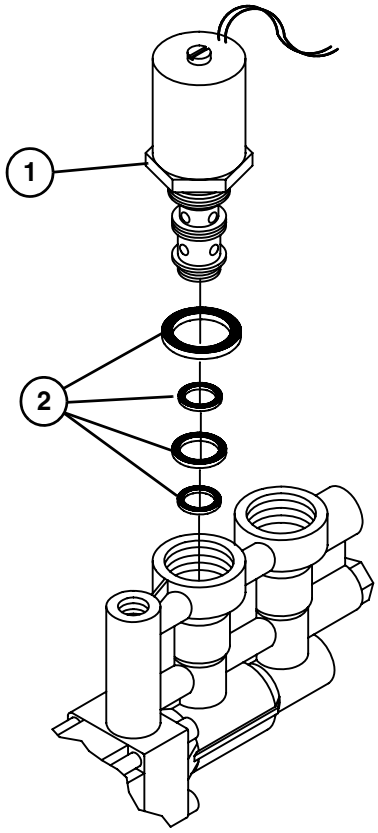
Valve Section Solenoid Cartridge Valve

The solenoid cartridge valves can be replaced as a complete unit or repaired by replacing seals. If troubleshooting determines the coil is bad, replace the complete unit.

Seals - Replace

To replace seals:

1. Remove cartridge **(1)** to be repaired from the valve section.
2. Remove old seals **(2)**.
3. Install new seals in order old ones were removed.
4. Dip cartridge in clean, filtered oil.
5. Screw cartridge in by hand until top O-ring is met.
6. Torque to 20 ft-lb (27 Nm).



Cylinders

If troubleshooting tests reveal cylinders are leaking, they can be removed and replaced as a complete unit or they can repaired. Repair kits are available for all of the cylinders.

Listed below are some general things to keep in mind when removing a cylinder for replacement or repair:

1. When removing cylinders, always remove as much of the load (weight) from the cylinder as possible. This would apply mainly to the machine level, trencher boom lift, trench cleaner fold, trench cleaner shoe, and conveyor fold cylinders.

   For example, if replacing a machine level cylinder, lower machine completely. If the machine cannot be lowered, support it with a suitable lifting device and jack stands so that it will not drop when the cylinder is removed.

2. Relieve pressure in the hydraulic system before disconnecting hoses or performing work on the system.
3. Label hoses to make it easier when reinstalling. Plug hoses and cap fittings to keep out dirt.

Reverse removal procedure to install cylinders.

NOTE: When installing cylinders that contain lock valves, the cylinder must be filled with oil before installation. The lock valve cartridges will need to be removed from cylinders before filling. Refer to page **6C-27** page for information on lock valves.

Special Tools

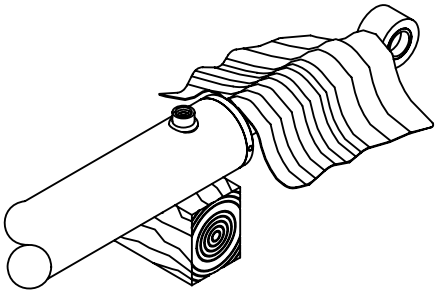
- vise, equipped with aluminum-gripped jaws
- spanner wrench with hardened pin
- rubber hammer
- torque wrench capable of producing 350 ft-lb (475 Nm)
- hydraulic porta-power with pressure gauge
- container for holding waste oil
- tapered ring compressor
- snap ring pliers

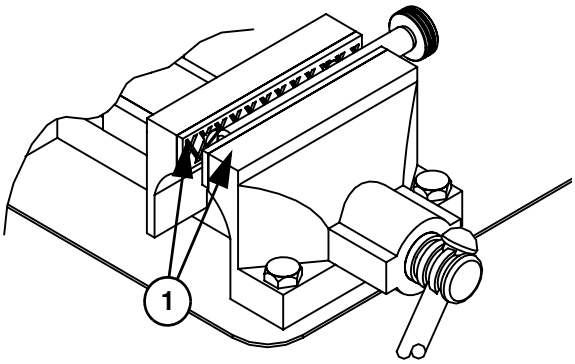
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Cylinder Disassembly Precautions

The cylinder illustrated in the repair procedures is a generic representation. The procedures for tearing down a cylinder to install a repair kit are the same for all the cylinders on the machine.

IMPORTANT: Protect rod assembly when extended to avoid damage to chrome surfaces. Use aluminum covers on jaws of vise **(1)** to grip rod assembly without clevis.

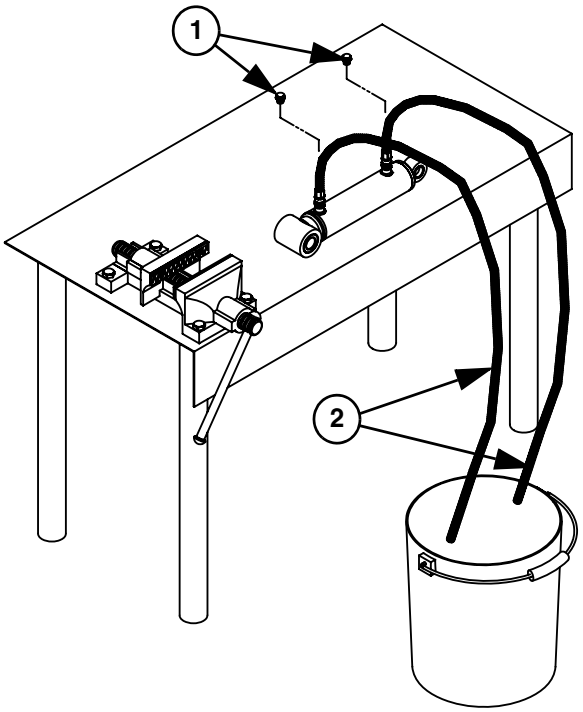




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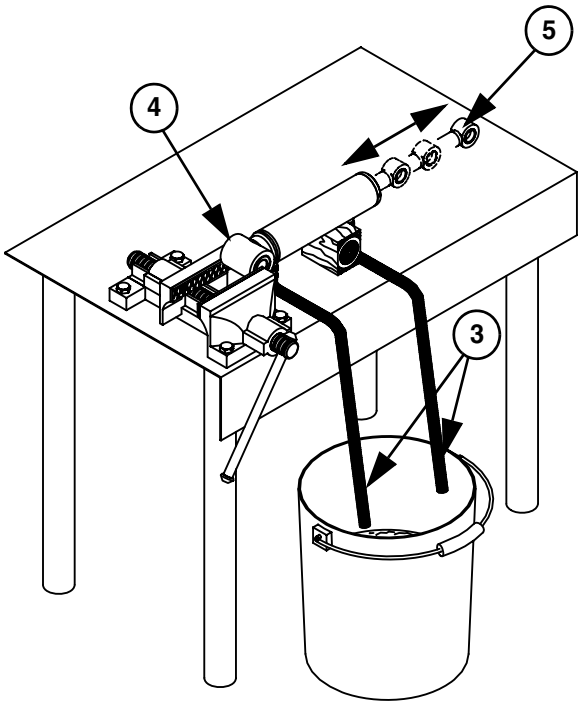
Cylinder Disassembly

1. Place cylinder on a clean surface.
2. Remove cylinder port O-ring boss plugs **(1)** and attach drain hoses **(2)**.



3. Drain oil into a suitable container. Do not allow hose ends **(3)** to become submerged in fluid or oil will be drawn back into cylinder.
4. Clamp base clevis **(4)** into a vise and support cylinder with a block of wood.
5. Force hydraulic oil from cylinder by moving rod **(5)**.

IMPORTANT: Do not use air to force rod in.



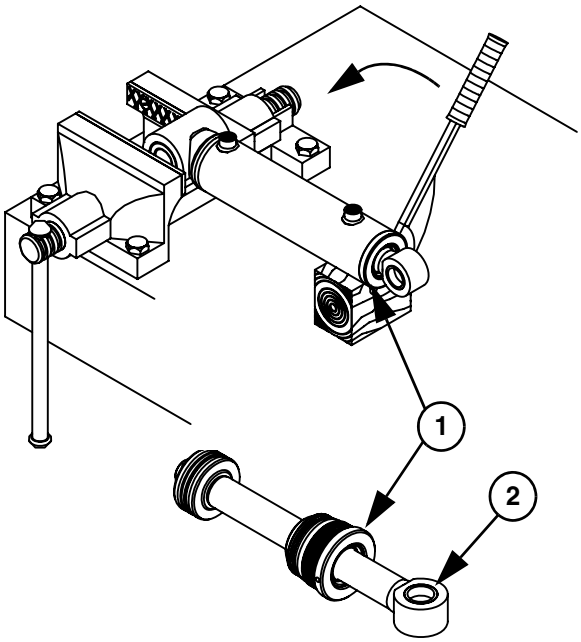
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Cylinder Rod Removal

For Threaded Gland

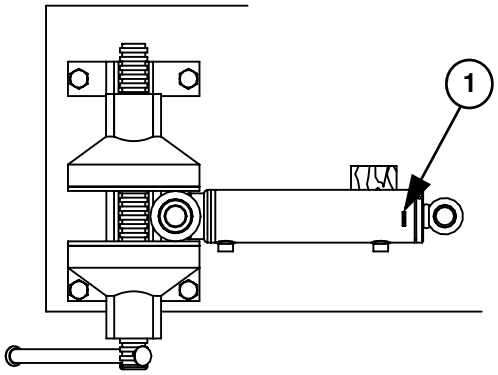
1. Remove gland **(1)** with spanner wrench. If the cylinder has a snap ring retaining the gland, remove it with standard snap ring pliers.
2. Pull rod assembly **(2)** from cylinder tube.

NOTE: If unable to remove rod assembly, use procedures under **Stuck Rod Removal** page 6C-14.



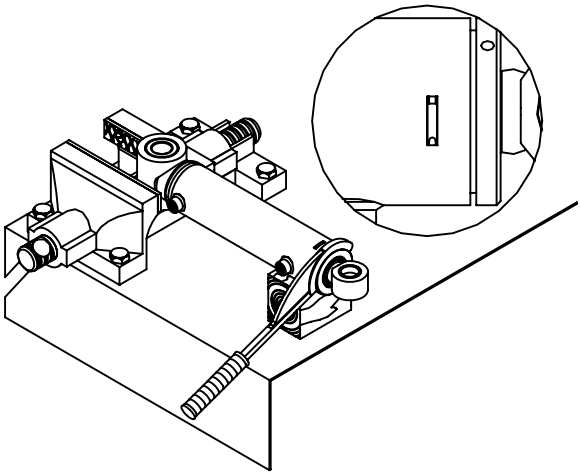
For Retaining Wire Gland

1. Clamp cylinder with wire slot **(1)** up.



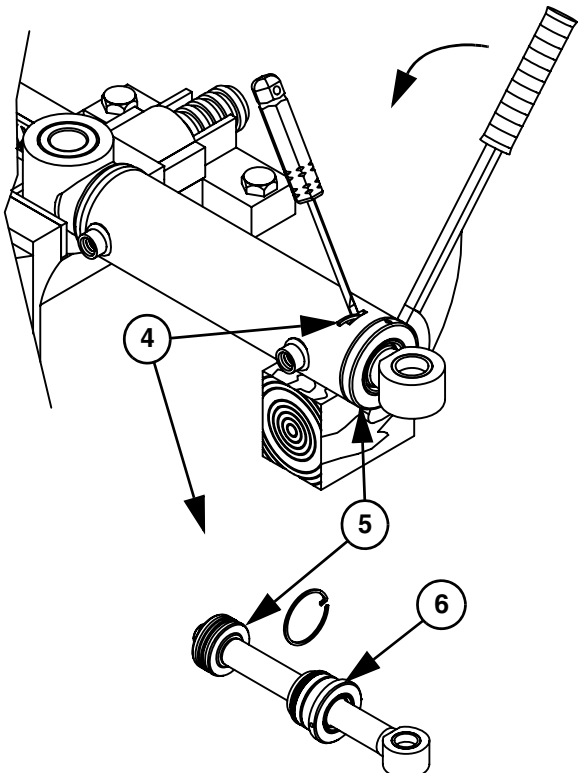
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2. Turn gland **(2)**, with spanner wrench, until leading edge of retaining wire **(3)** appears in slot.



3. Insert a flat-bladed screwdriver under retaining wire **(4)**. Turn gland **(5)**, while guiding retaining wire out of slot.
4. Remove retaining wire from cylinder.
5. Pull rod assembly **(6)** from cylinder tube.

NOTE: If unable to remove rod assembly, use procedures under **Stuck Rod Removal** page 6C-14.

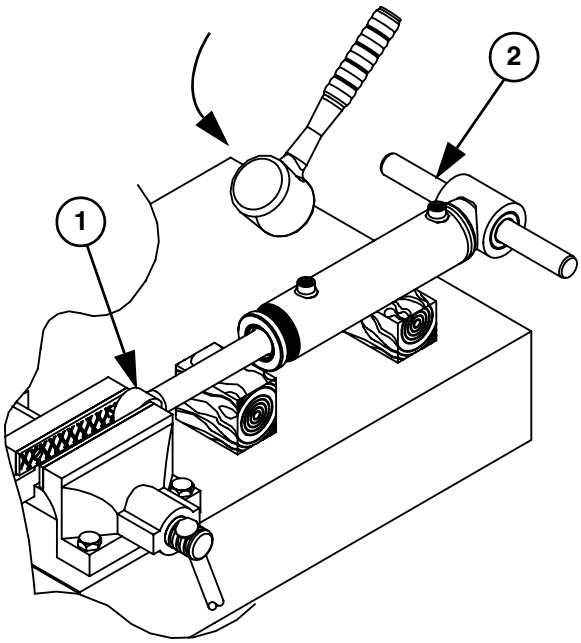


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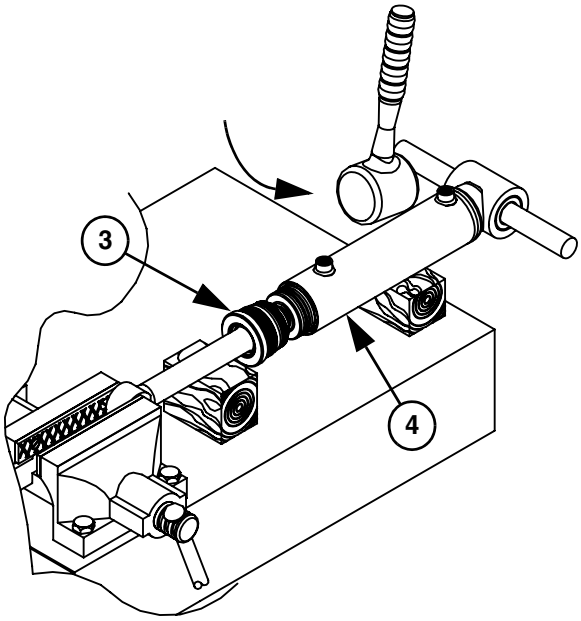
Stuck Rod Removal

Manual Procedure

1. Clamp rod eye **(1)** into a vise. Support rod assembly and cylinder with blocks of wood.
2. Insert a pin into base eye **(2)**.



3. Pound on pin with a rubber hammer, removing rod assembly **(3)** from cylinder tube **(4)**.



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Pressure Procedure

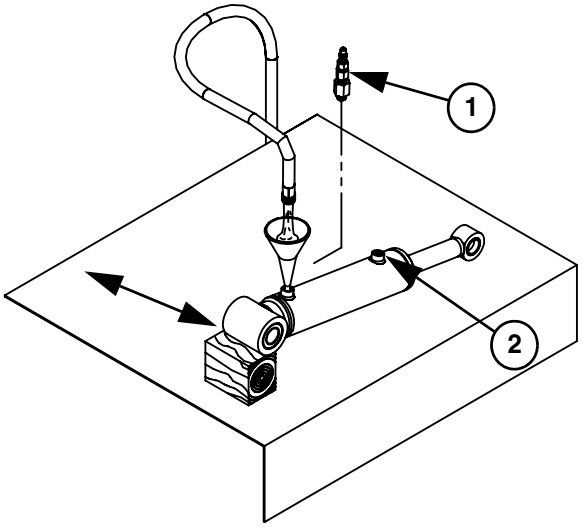
WARNING: To prevent uncontrolled rod movement, do not use compressed air to remove rod assembly. Serious injury can result if struck by rod.

IMPORTANT: Instructions written for use with Vermeer hand-powered test kit, P/N 152623001.

Water is non-compressible and easy to clean up after completing the procedure.

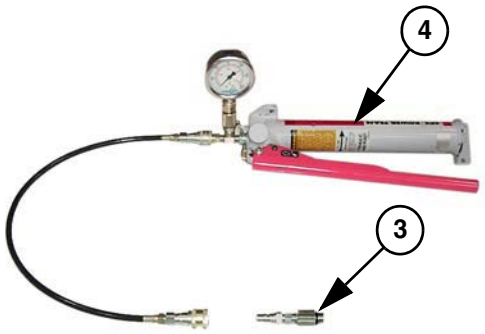
1. Place base eye on a piece of wood. Fill base port with water. Tighten adapter fitting **(1)** into base port.

NOTE: Should water begin to flow from rod port **(2)**, plug port with an O-ring boss plug (see step 5) only if piston is past rod port. Continue to fill base port. When full, begin step 2.



2. Install adapter fitting **(3)** to base end port on cylinder.
3. Attach hand powered test pump **(4)** to adapter fitting **(3)**.
4. Pump handle applying pressure to base end.

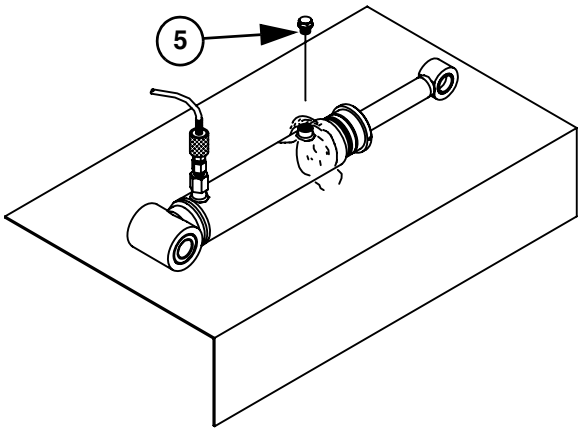
IMPORTANT: Do not exceed 3000 psi (200 bar).



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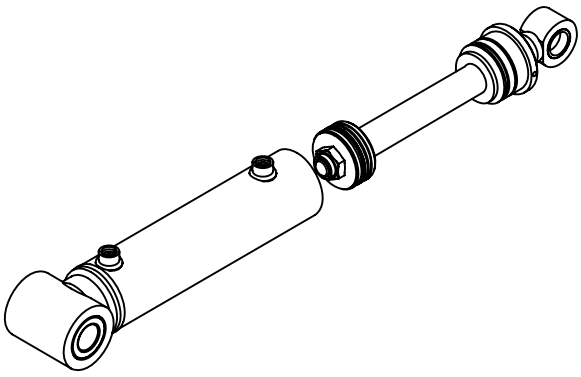
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5. When water starts to flow once piston is past rod port, plug port using an O-ring boss plug **(5)**.
6. Continue to pump, pushing rod assembly out with pressure.



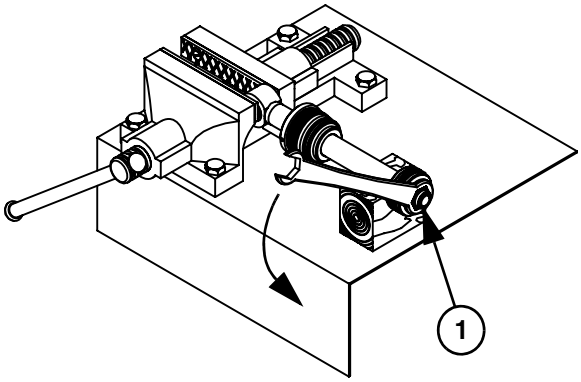
7. Remove test pump, adapter fitting and O-ring boss plug.
8. If this procedure does not work, try manual method.

NOTE: If rod is not forced out under pressure, examine exterior of cylinder tube for a slight oval or a dent. An oval or dented cylinder tube must be replaced. The rod may also be bent. A bent rod must be replaced, not straightened.

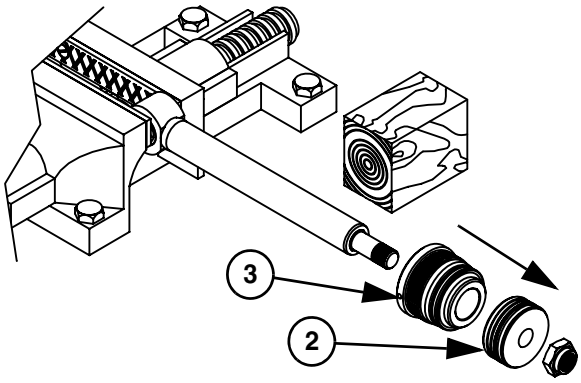


Piston Removal

1. Clamp rod clevis end in a vise. Support rod with a block of wood.
2. Remove piston lock nut **(1)**.

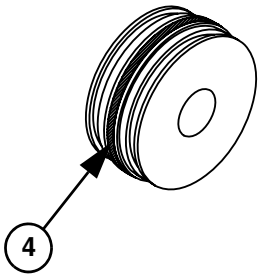


3. Remove piston **(2)** and gland **(3)**.



IMPORTANT: Do not damage surfaces of cylinder components.

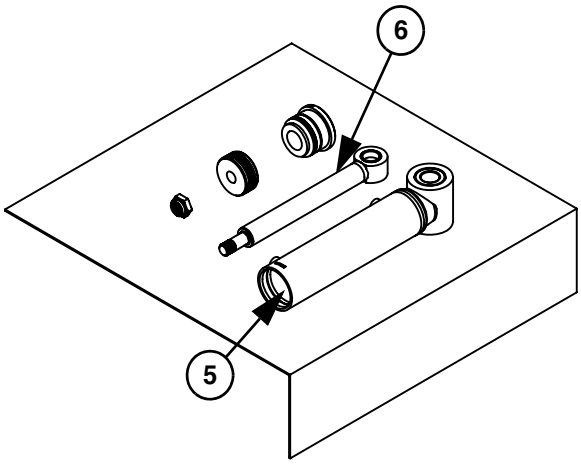
4. Remove all seals from gland, piston, and rod.
5. Cut Teflon seal **(4)** to remove.



Continued on next page...

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6. Thoroughly clean all parts with solvent.
7. Dry these parts.
8. Inspect the bore of tube **(5)** and chrome parts of rod **(6)** for scoring. Smooth visual lines are acceptable. Replace parts with sharp-edged lines.

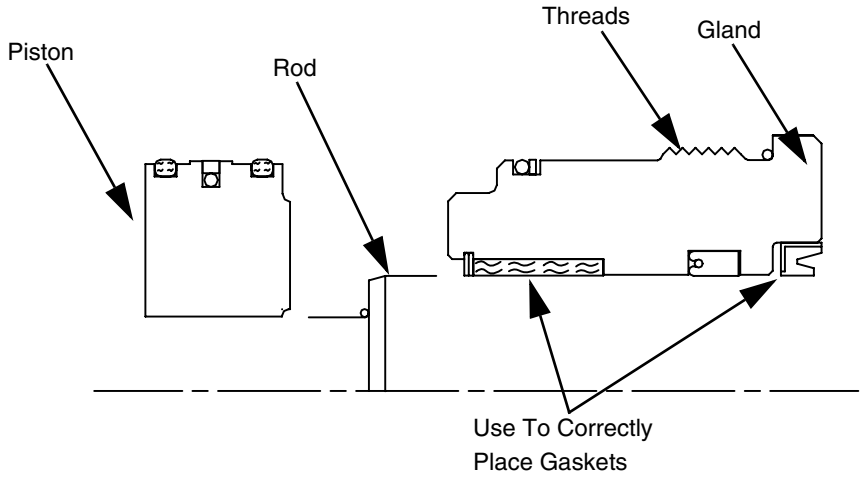


Seal Information Reference

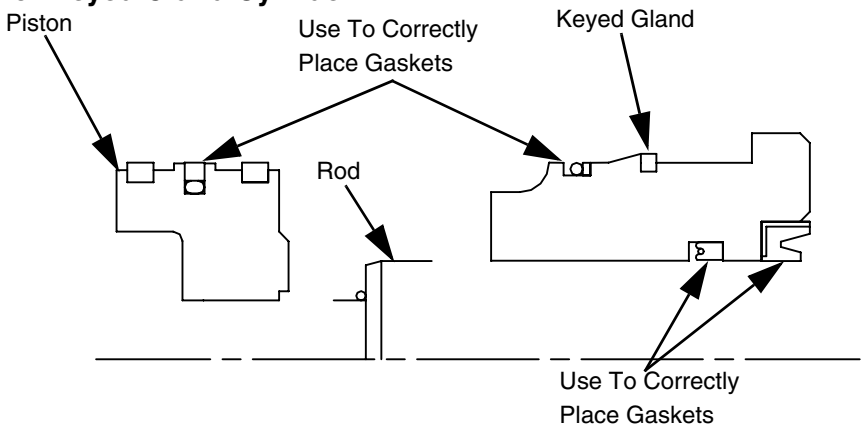
NOTE: Order seal kit from T655III *Parts Manual*.

- Replace all seals.
- Check orientation of seals.

For Threaded Gland Cylinder



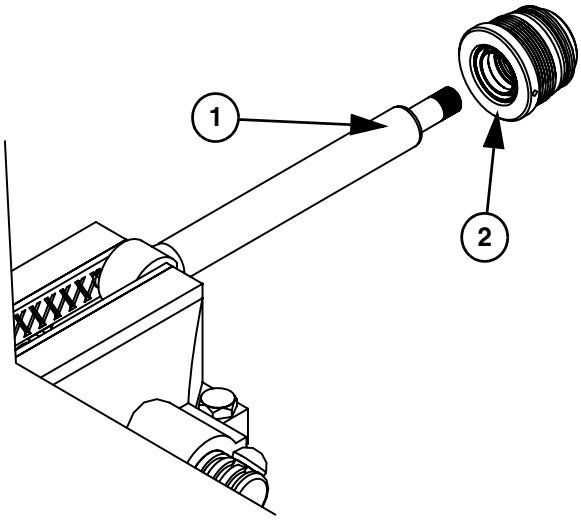
For Keyed Gland Cylinder



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Piston Install

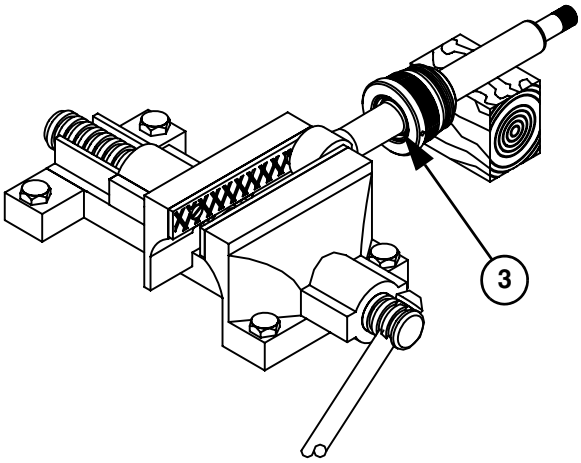
1. Clamp rod eye end in a vise.
2. Apply a coat of clean hydraulic oil to rod at point **(1)** and inside gland at point **(2)**.



IMPORTANT: Do not scar internal gland seals on rod threads.

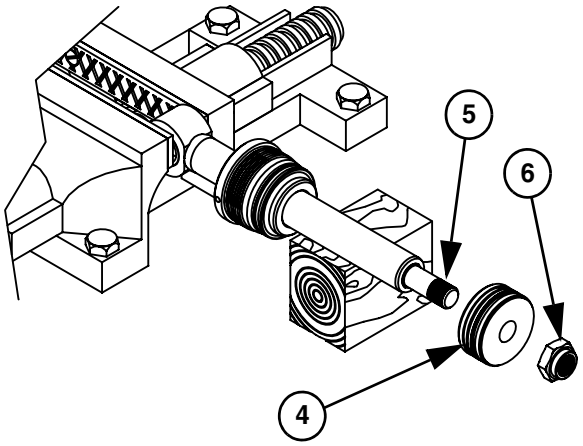
NOTE: Plastic wrap may be used to cover rod threads.

3. Slide gland, with wiper seal **(3)** toward vise, onto rod.
4. Place a block of wood under rod.

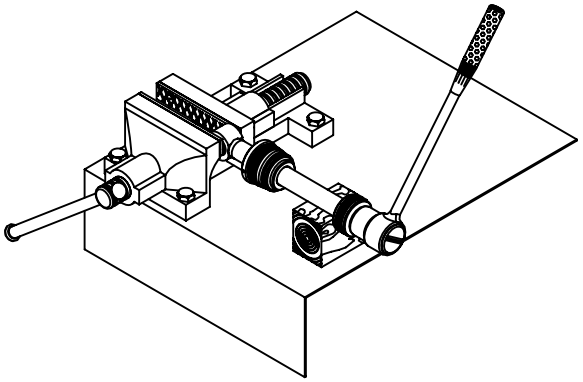


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5. Slide piston **(4)** onto rod. Apply clean hydraulic oil to threads **(5).** Start lock nut **(6)**.



6. Tighten lock nut with torque wrench. Use standard torque for the size of nut used.
7. Remove rod assembly and place on a clean surface.

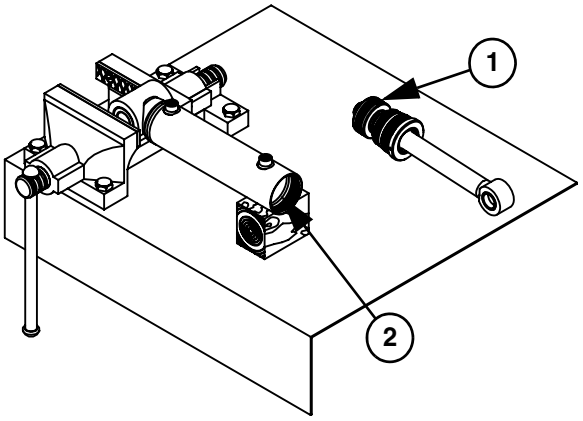


Rod Install

1. Clamp cylinder base eye in vise and support cylinder with a block of wood.

NOTE: Threaded gland assembly shown. For cylinder with retaining wire, clamp into vise with slot to the top.

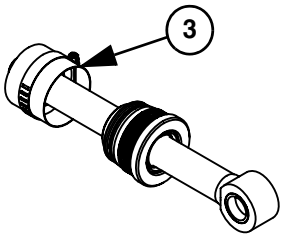
2. Apply a coat of clean hydraulic oil around piston **(1)** and inside cylinder at point **(2)**.



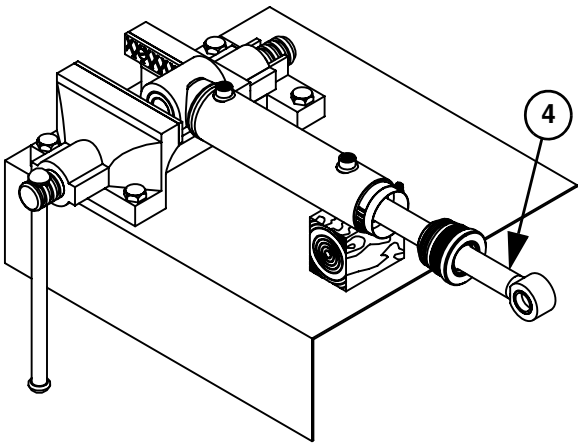
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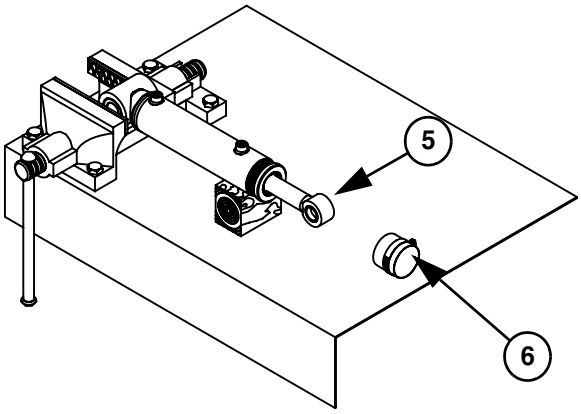
3. Place tapered ring compressor **(3)** around piston, compressing Teflon piston seal.



4. Insert rod assembly **(4)** into cylinder.



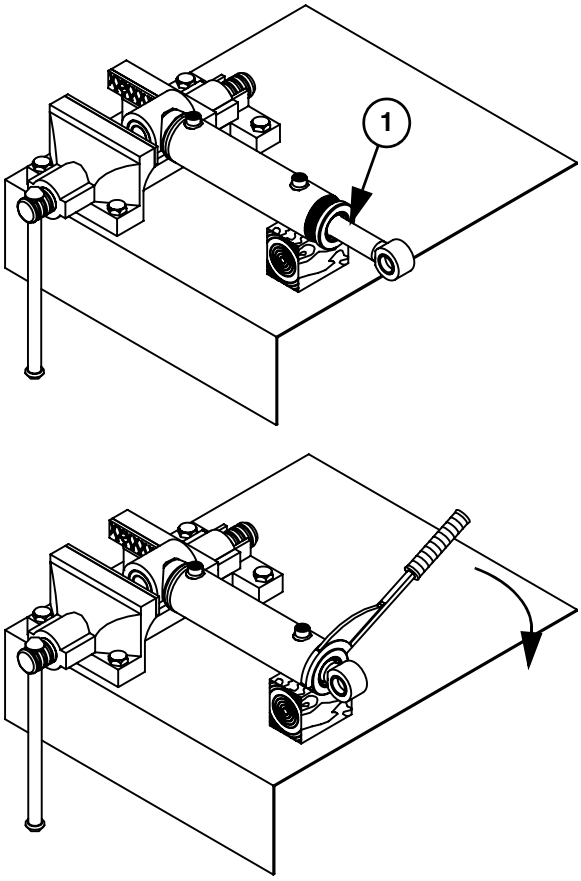
5. Push rod assembly **(5)** into cylinder.
6. Remove tapered ring compressor **(6).**
7. Refer to gland tightening procedures on following page.



Threaded Gland Tightening Procedures

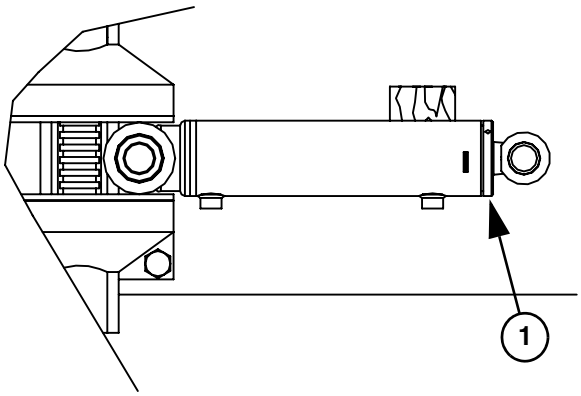
Do not scar external seals on internal threads

1. Start threaded gland **(1)**.
2. Tighten gland.



Retaining Wire Gland Tightening Procedures

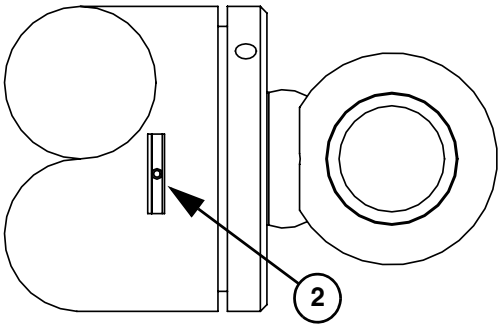
1. Insert gland **(1)** into the cylinder.



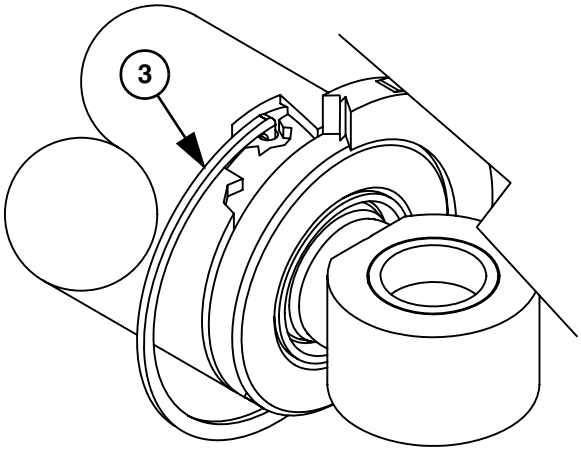
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2. Rotate gland until retaining wire countersink hole **(2)** is visible.

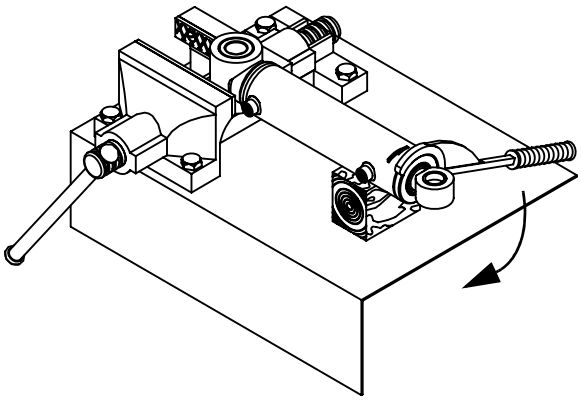


3. Insert retaining wire **(3)** into hole.



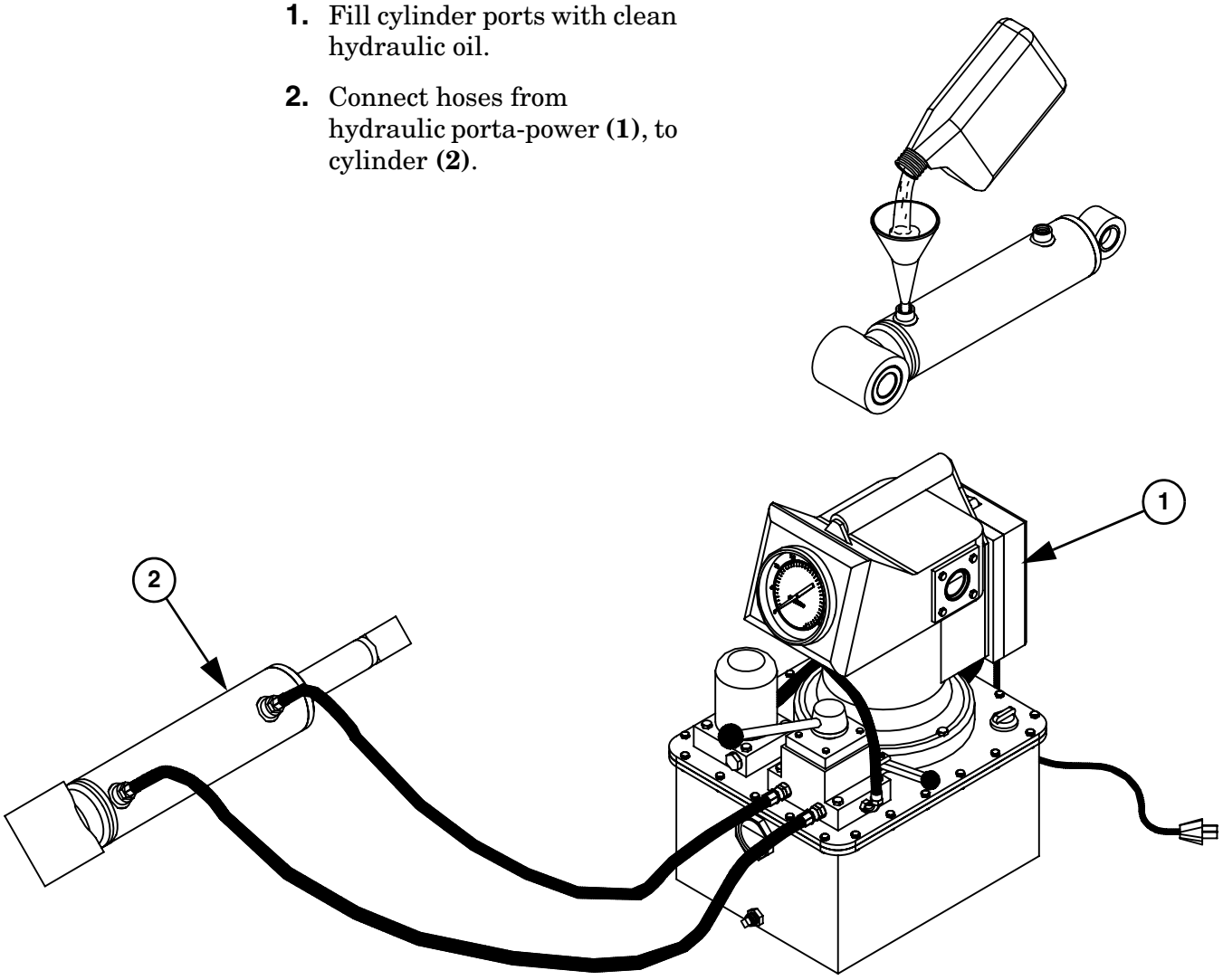
4. Turn gland until retaining wire is fully inserted.
5. Continue turning gland one half revolution past visible end of retaining wire.

IMPORTANT: Do not leave wire end visible in slot. Retaining wire can vibrate out.



Cylinder Post Repair Check

1. Fill cylinder ports with clean hydraulic oil.
2. Connect hoses from hydraulic porta-power **(1)**, to cylinder **(2)**.



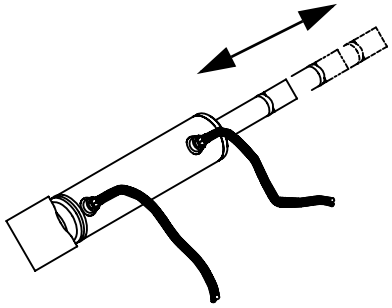
NOTE: Item **(1)** is representative of a two-way porta-power.

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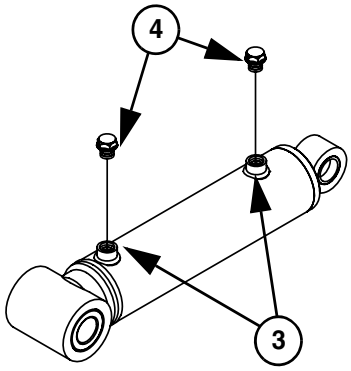
NOTE: Erratic movement is an indication of entrapped air.

3. Cycle cylinder at 500 psi (35 bar) until erratic movement has stopped.
4. Perform a high pressure test. Cycle cylinder at 3000 psi (200 bar).



NOTE: Correct assembly is indicated by non-leaking seals.

5. Remove hydraulic hoses and plug cylinder ports **(3)** with O-ring boss plugs **(4)**.
6. Install cylinder.



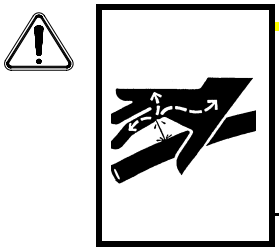
Cylinder Lock Valves

The lock valves can be replaced as a complete unit or repaired by replacing seals.

The boom lift, trench cleaner shoe, and dirt drags functions all have external lock valves in the circuits. The lock valves lock the oil in the cylinders, preventing the cylinders from creeping as a result of seepage past the valve spools. The external lock valve for the boom lift prevents the trencher attachment from working its way out of the ground when operating.

The machine level, trench cleaner fold, and boom lift functions have an additional internal lock valve installed in the base end of the cylinders. These valves prevent the machine, trench cleaner fold, and trencher boom from dropping if a hose or fitting fails.

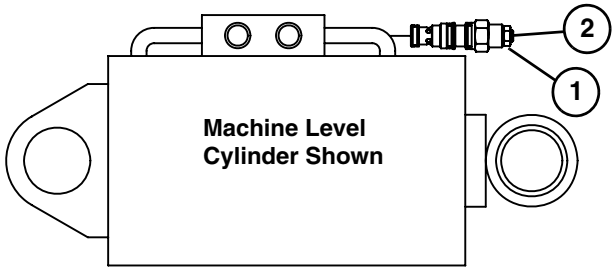
NOTE: If a malfunction occurs in one of these circuits and a cylinder will only work in one direction, the lock valves should be investigated.



WARNING: Some residual pressure will probably remain in the cylinders equipped with lock valve cartridges in the base ends. Use extreme caution when removing a cartridge. The cartridge will be released with great force if residual pressure remains in the cylinder. Do not stand in front of the cartridge when removing it.

Remove

1. Follow *"Shutdown Procedure," page* **2-1**.
2. If a machine function equipped with cylinders containing lock valves cannot be completely lowered, including machine level, trencher boom, trench cleaner fold, support it with a suitable lifting device so that it will not drop when cartridge is removed.



3. Relieve trapped pressure in cylinder by loosening jam nut **(1)** and turning allen head screw **(2)** completely in.
4. Slowly loosen and remove lock valve. Inspect seals. If damaged, replace. See following page. If seals are not damaged and the function could not be completely lowered, replace complete cartridge valve.

Install

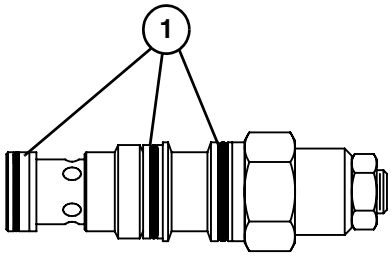
- Torque cartridge 30–35 ft-lb (40–47 Nm).

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Seals - Replace

To replace seals:



1. Remove old seals **(1)**. Note orientation of the backup washers and O-rings. This will ensure new seals will be installed correctly.
2. Install new seals in order old ones were removed.
3. Inspect manifold cavity for burrs or other irregularities which could damage O-rings during installation.
4. Fill cylinder with clean filtered oil.
5. Dip cartridge in clean, filtered oil.
6. Screw cartridge in by hand until top O-ring is met.
7. Torque hex to 30–35 ft-lb (40–47 Nm).

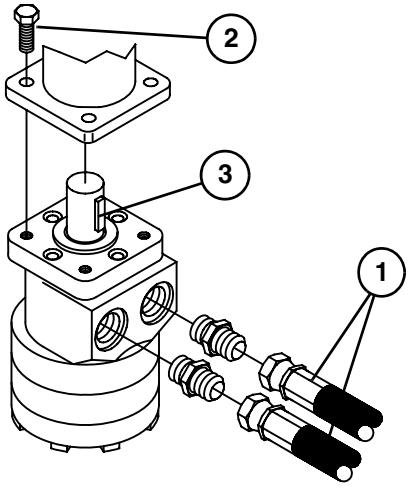
Conveyor Shift Motor B1

The motor can be replaced as a complete unit or repaired by replacing seals.

Refer to page **9C-15** for information on replacing or repairing conveyor shift gearbox.

Remove

To remove motor:



1. Follow *"Shutdown Procedure," page* **2-1** .
2. Label each hose **(1)**. This will make it easier when reinstalling motor. Cap fittings and plug all hoses.
3. Remove four bolts **(2)** securing motor to gearbox. Remove motor.
4. Retain key **(3)** for reuse.

Install

Reverse removal procedure to install motor.

- Remove fittings from old motor and install to the new motor.
- Torque bolts according to standard torque charts.

Continued on next page...

Motor Seals - Replace

To replace seals:

Refer to previous page and follow instructions for removing and installing motor.

NOTE: A complete repair manual with instructions on replacing the seals can be located on the internet. The manual is in PDF form and is located under Eaton product literature library. Refer to the Eaton Corporation website for information.

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Chapter 7—Ground Drive Subsystem

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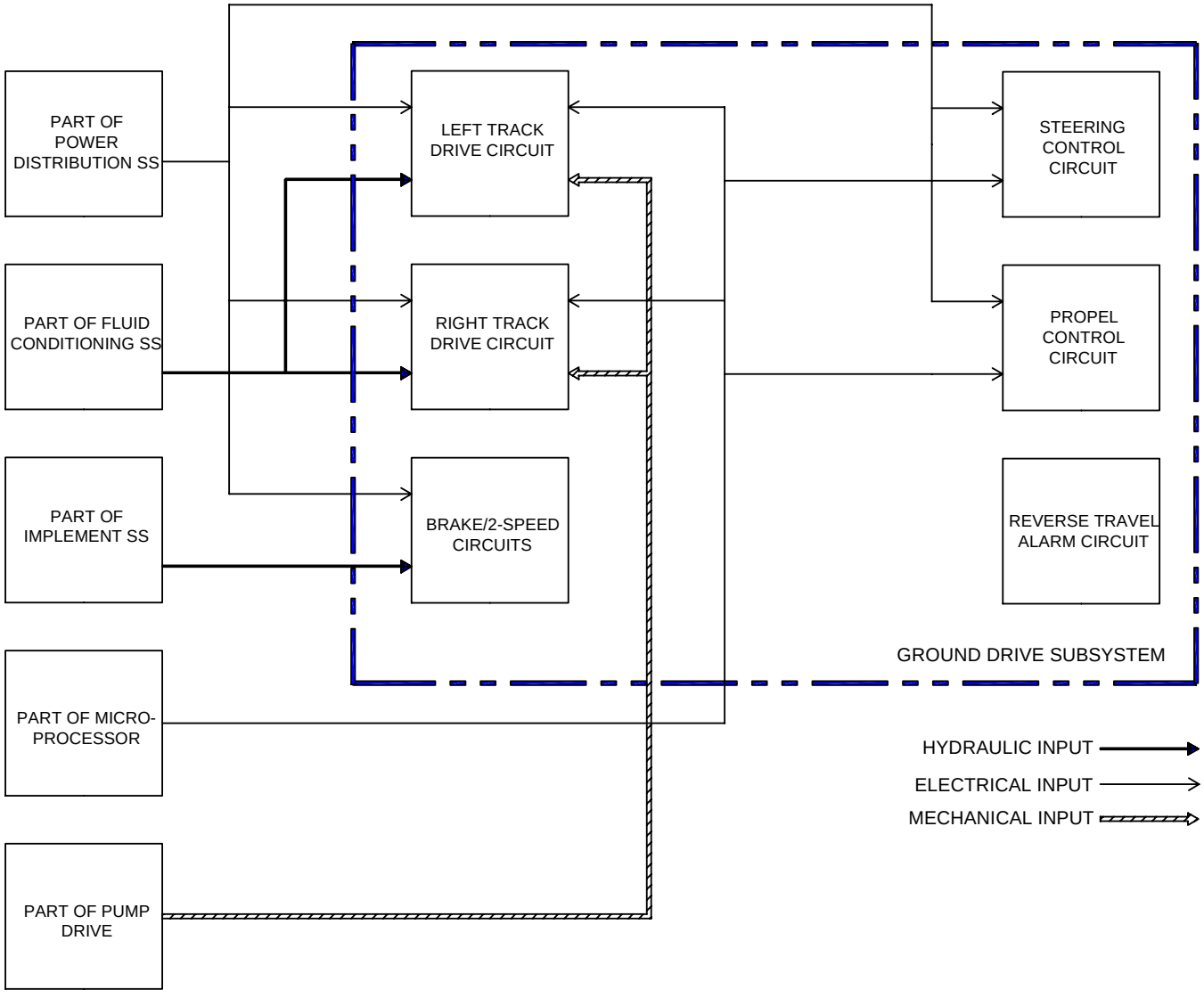
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Chapter 7: Ground Drive Subsystem

Section A: Theory

OVERVIEW

MAP



Lines and arrows on the MAP illustrate the relationships of the subsystems. The Microprocessor, Pump Drive, Power Distribution, Fluid Conditioning, and Implement subsystems supply the electrical, hydraulic, and mechanical input necessary for operation.

Continued on next page...

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The Ground Drive subsystem consists of the circuits and components necessary for left and right track drive function. This system is electronically controlled, and hydraulically actuated. There is an independent left track drive circuit and right track drive circuit. The track drive circuits are controlled using the various electronic control modules, sensors, and switches, as well as the microprocessor (TEC 2000).

The hydraulic systems used to propel the track drives are referred to as closed-loop hydrostatic systems. A common pump drive driven off the engine rotates the pumps. While the system is in operation, one side of the loop will be under high pressure (load generated pressure), while the opposite side of the loop is at approximately charge pressure. When the control is in NEUTRAL position (pump swashplate neutral), both sides of the closed-loop are at charge pressure.

The theory of operation for the ground drive system is separated into two parts:

- components shared by both circuits (Refer to "Operation - Electrical Control Circuits/Components," **page 7A-7**).
- left and right track drive circuits (Refer to "Left and Right Track Drive Circuits," **page 7A-7**).

Circuits/Components

Circuits/Components Shared by Left and Right Track Drives:

Fluid Conditioning Components
Pump Drive Assembly A10
Microprocessor A5
Propel Control A8
Reverse Travel Alarm AD1
Steering Control A7
2-Speed Valve and Park Brake Assembly A2

Left Track Circuit:

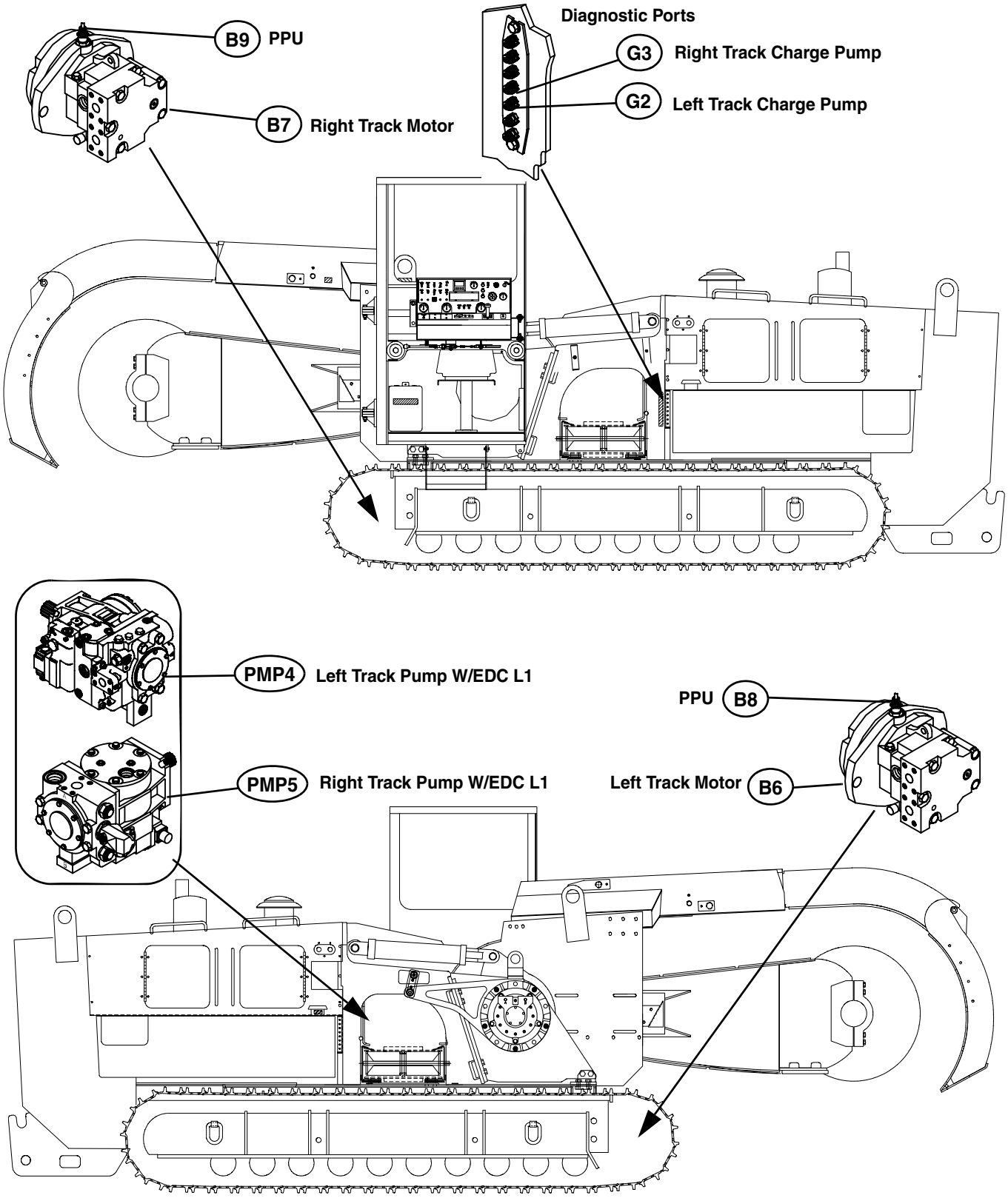
Left Track Hydraulic Pump PMP4
Left Track Hydraulic Motor B6
Left Track Charge Pump Filter FL8
Left Track Pressure Gauge PG3
Left Track Charge Pressure Diagnostic Port G2
Left Track PPU B8

Right Track Circuit:

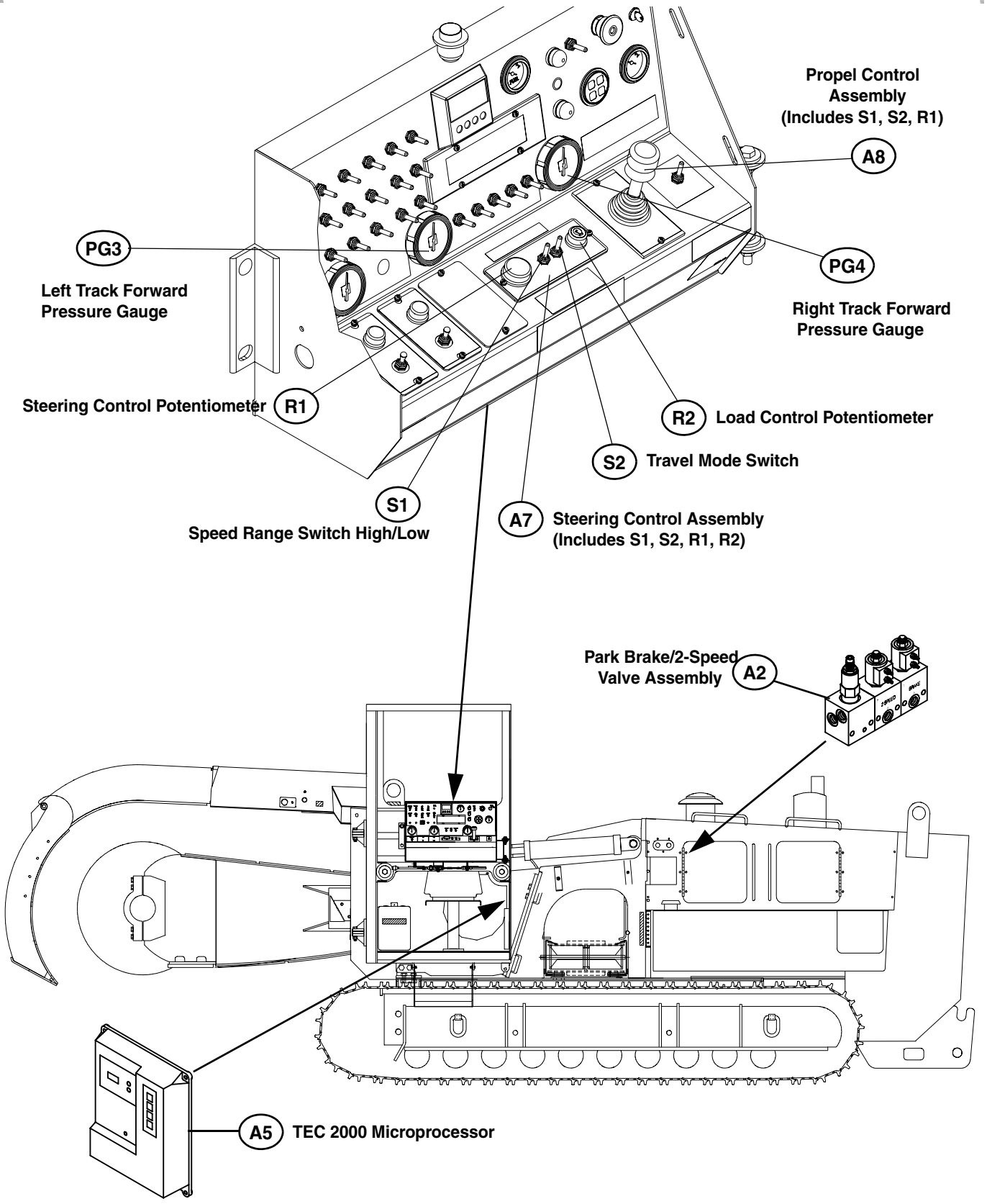
Right Track Hydraulic Pump PMP5
Right Track Hydraulic Motor B7
Right Track Charge Pump Filter FL9
Right Track Pressure Gauge PG4
Right Track Charge Pressure Diagnostic Port G3
Right Track PPU B9

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Component Locations



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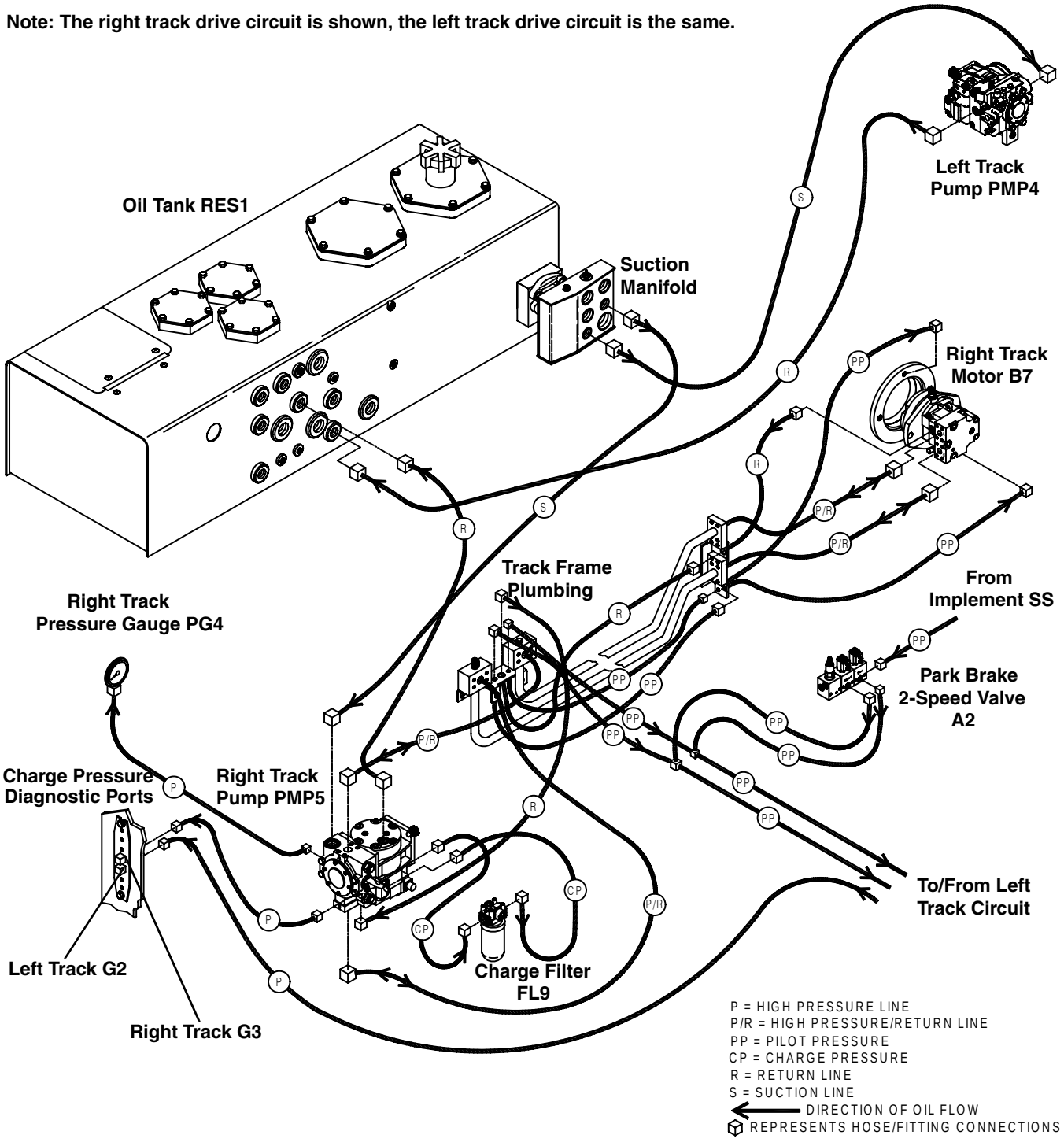

Propel Control Assembly (Includes S1, S2, R1)
A8
PG3
Left Track Forward Pressure Gauge
PG4
Right Track Forward Pressure Gauge
Steering Control Potentiometer
R1
R2
Load Control Potentiometer
S2
Travel Mode Switch
S1
Speed Range Switch High/Low
A7
Steering Control Assembly (Includes S1, S2, R1, R2)
Park Brake/2-Speed Valve Assembly
A2
A5
TEC 2000 Microprocessor

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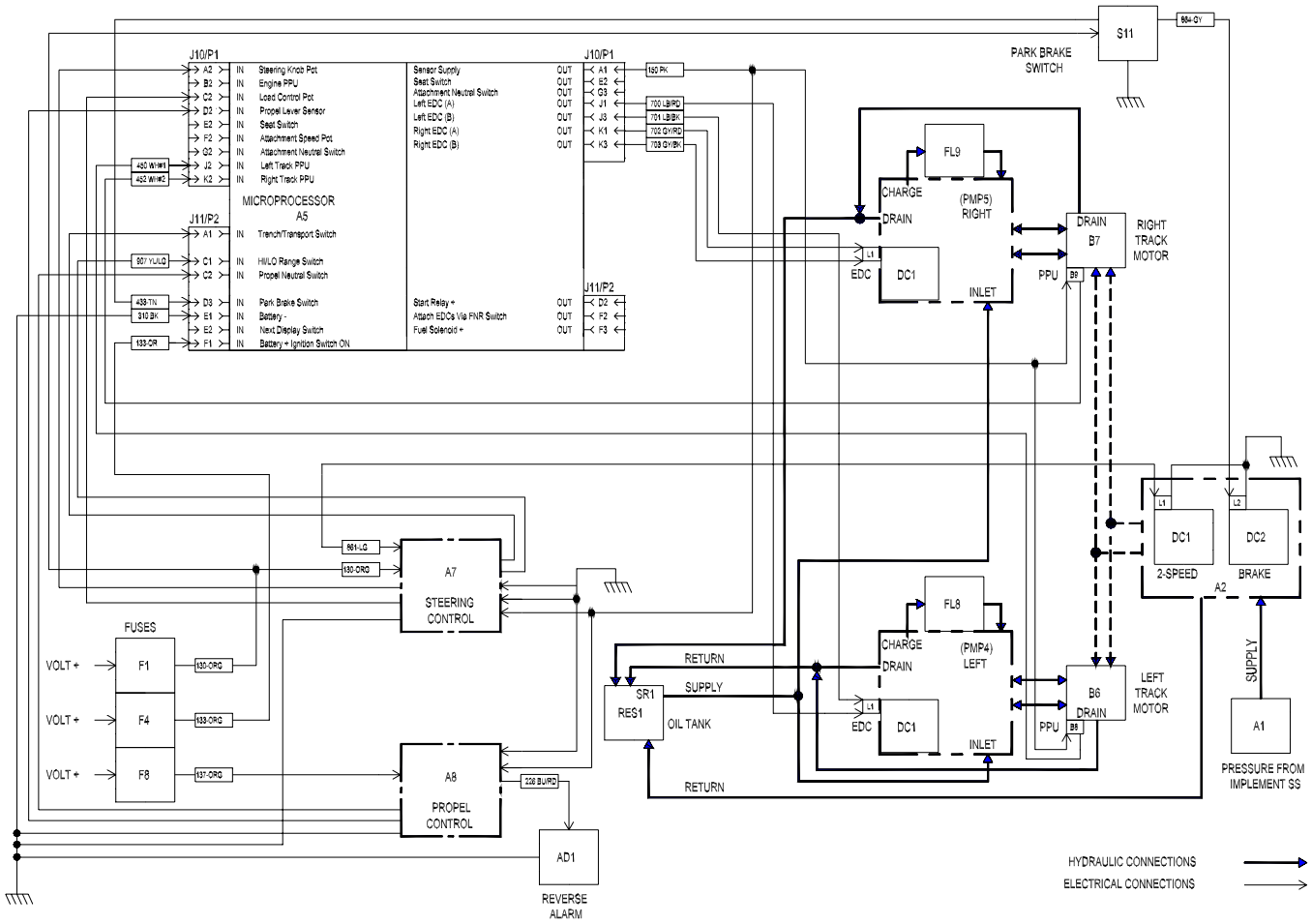
Hydraulic Hose Connections - (Right Track Shown)

Note: Orientation of components does not reflect actual machine configuration.

Note: The right track drive circuit is shown, the left track drive circuit is the same.



LEFT AND RIGHT TRACK DRIVE CIRCUITS



Operation - Electrical Control Circuits/Components

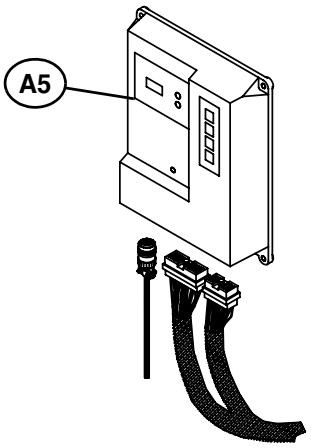
Although the left and right track drive circuits are two separate circuits, they share some common electrical control circuits and components as well as a common 2-speed and brake valve assembly. These components work in conjunction with both track drives simultaneously. Therefore, the theory of operation of these circuits and components is discussed here.

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TEC 2000 Microprocessor A5

The microprocessor A5 is the main control for several circuits in multiple subsystems. In this chapter, the theory of operation discusses the microprocessor and how it relates to just those electrical controls that are common to the track drive circuits.

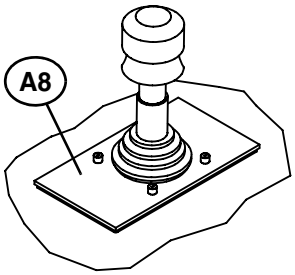
For complete operating information on the microprocessor, refer to Chapter 2 System Information.



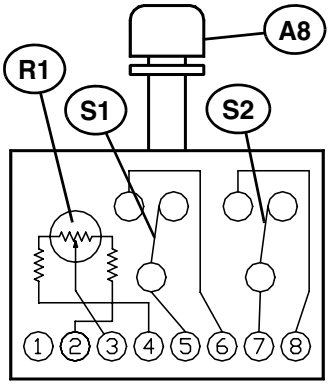
Propel Control

The propel control assembly A8 installed on the control panel incorporates three different control functions, including:

- FORWARD ground drive
- REVERSE ground drive
- ground drive speed



The propel control consists of two internal switches S1 & S2 and one internal potentiometer R1. Switch S1 signals the TEC 2000 microprocessor when the propel control is out of NEUTRAL. Switch S2 activates an audible warning alarm AD1 that sounds when in REVERSE direction. See following page for information on alarm. The potentiometer R1 controls track drive speed.

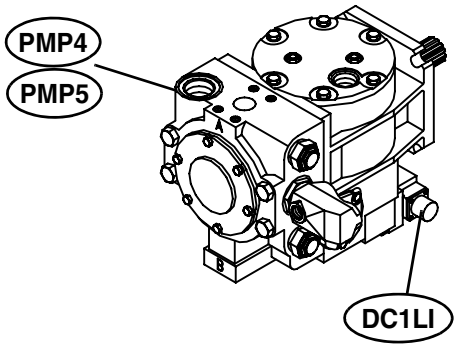


NOTE: The propel control A8 is part of the machines START interlock function. If the engine is shut down and the handle is not in the NEUTRAL position, the engine will not start. Refer to Engine subsystem Theory Chapter 5A for more information on the START interlock functions.

Continued on next page...

Direction control is actuated when the propel handle is moved from NEUTRAL position. The direction switch and poteniometer get voltage and ground from the microprocessor. When propel handle is pushed for FORWARD, or pulled for REVERSE, the handle engages and closes the direction switch. This completes the circuit, sending an input signal to the microprocessor. When moved, the propel handle also turns the potentiometer sending an input signal to the microprocessor.

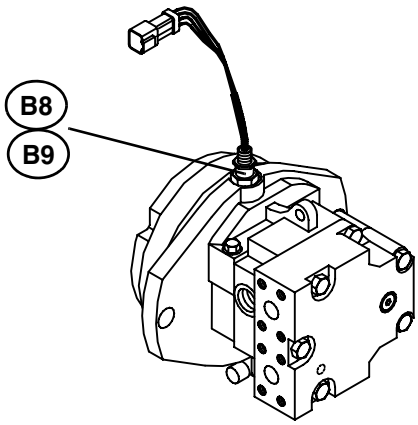
The microprocessor supplies variable current depending on the position of propel handle from NEUTRAL, to the track pump EDCs (electronic displacement control) DC1L1. The current flows through the EDCs in one direction for FORWARD and in the opposite direction for REVERSE.



Drive Motor PPUs

The track motor PPUs B8 & B9 get voltage from the microprocessor and ground from the machine chassis. They supply a signal in hertz to the microprocessor. The microprocessor uses the signal to determine the speed of both motors.

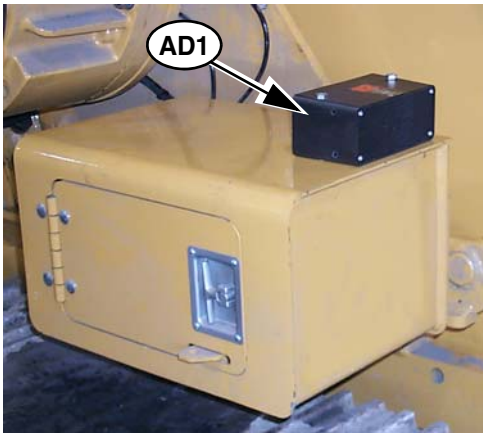
The PPU is composed of a speed ring and a sensor. By knowing the motor speeds, the microprocessor can regulate the current to each EDC to ensure machine will track straight.



REVERSE Travel Alarm Circuit

The REVERSE travel alarm switch A8S2 intregal to propel control, gets voltage from a 10-amp fuse F8. When propel is pulled for REVERSE, the handle engages and closes the switch. This completes the circuit, sending input voltage to the REVERSE travel alarm AD1 mounted on the tool storage box.

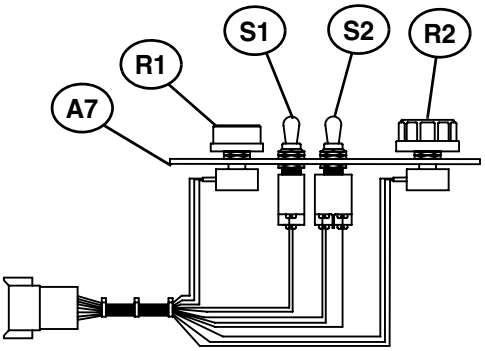
The alarm will sound repeatedly while the REVERSE function is actuated.



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Steering Control

NOTE: The track steering control assembly A7 installed on the control panel incorporates four different control functions, including:



- R1 - steering
- S1 - speed range
- S2 - travel mode
- R2 - load RPM

The steering knob R1 controls an internal potentiometer that gets voltage and ground from the microprocessor. The potentiometer sends a signal to the computer. When the potentiometer (pot) is turned to full maximum, the controller is sensing max. voltage. When the pot is turned to full minimum, the controller is sensing min. voltage.

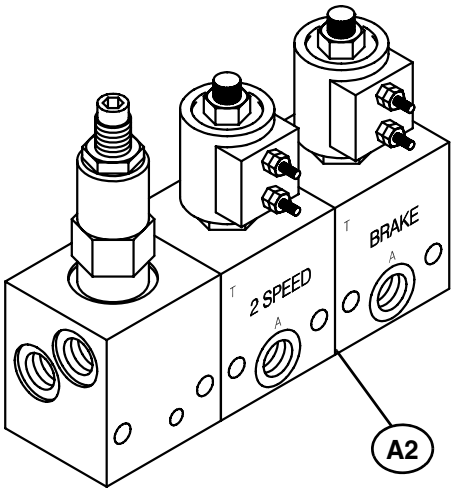
The direction in which the machine turns and the sharpness of the turn, depends on the amount of voltage the steering potentiometer supplies to the microprocessor.

When turning, the microprocessor ensures machine turns at the correct rate, depending on the position of the steering knob. Refer to 2-speed/park brake operation for information on speed range, travel mode, and load RPM.

2-Speed/Park Brake Control

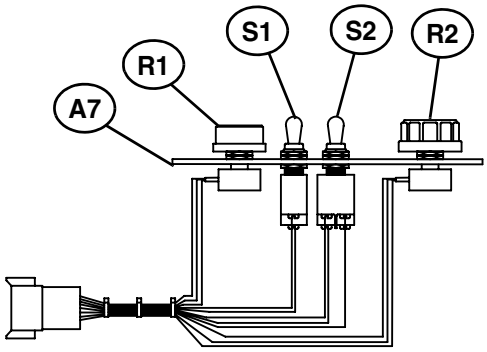
2-Speed Operation

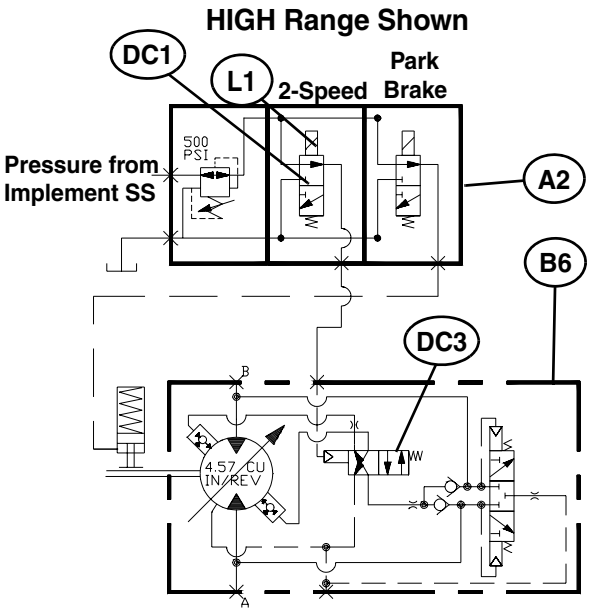
The 2-speed drive function is incorporated into one control valve assembly A2 along with the park brakes. Both functions are electrically-controlled and hydraulically-actuated using pilot pressure from the Implement subsystem.



Refer to “Park Brake Operation,” **page 7A-12** for brake information.

Continued on next page...





The track speed range switch A7S1 gets voltage from a 5-amp fuse F1 and ground from machine chassis.
With speed range switch in the LOW range position, the electrical circuit is open and solenoid DC1L1 is de-energized. When the switch is pushed to HIGH, a voltage path is complete to energize solenoid DC1L1.

Pilot pressure from the Implement subsystem will flow through valve DC1 and shift servo valve DC3. Valve DC3 ports pressurized oil to either side of a dual acting servo control piston. The servo piston rotates the swashplate through an angular rotation to vary the motor's displacement from full to minimum displacement.

In HIGH speed mode, the swashplate is at its minimum angle (minimum displacement) which yields greater output speed and less torque. In LOW speed mode, the swashplate is at its largest angle (full displacement) which yields greater output torque and less speed.

The travel mode switch A7S2 is used to switch from transport mode to trench mode. In transport mode (manual), the switch is closed and sends a ground signal to the microprocessor. The microprocessor determines the switch is in transport mode and disables the automatic load controls. The operator uses the propel handle and steering knob A7R1 to control track speed and turning. The tracks are able to counter-rotate on turns.

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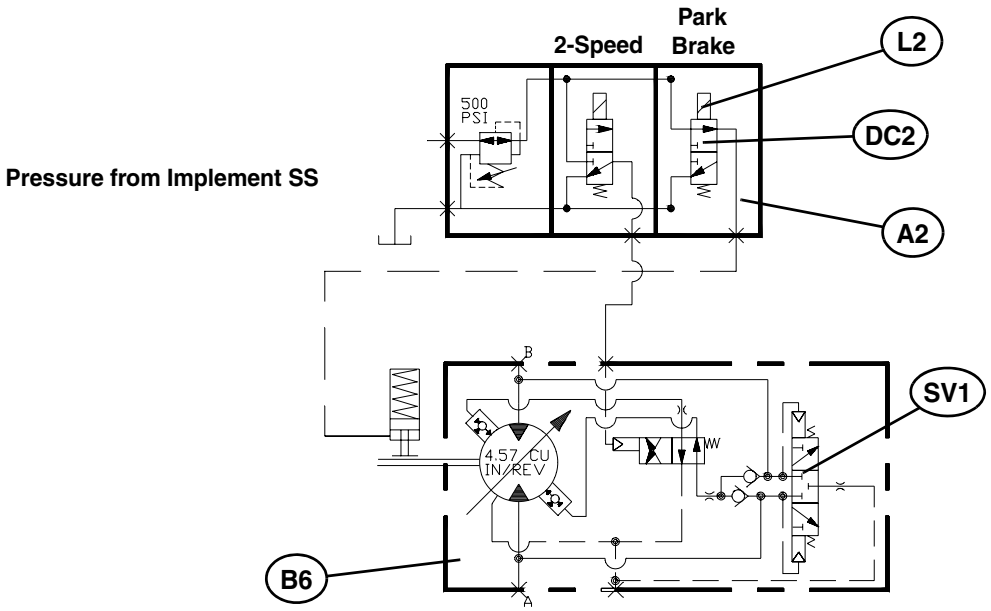
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In trench mode (Auto), the switch is open. The tracks will not counter-rotate. The automatic load controls will be enabled to automatically control track speed to maintain engine RPM according to the setting on the load control knob A7R2.

The load control knob is used when trenching in Auto mode. The load knob A7R2 gets voltage and ground from the microprocessor. The microprocessor uses the voltage input from the poteniometer to determine how far the engine RPM will pull down before ground drive slows down. The more the knob is turned clockwise the more the engine RPM will drop. The RPM drop should be set for the best productivity according to trenching conditions.

Park Brake Operation

The park brake as well as the 2-speed drive functions are incorporated into one control valve assembly A2. Refer to "2-Speed/Park Brake Control," page 7A-10 for information on 2-speed operation.



Brakes - Applied

NOTE: Refer to "MAP," page 7A-1 to view electrical switch designations.

The park brake control switch S11 is a 2-position maintained switch. The switch gets voltage from a 10-amp fuse F1 and ground from machine chassis. With the switch turned to the ON position, the control circuit is open (brakes are applied).

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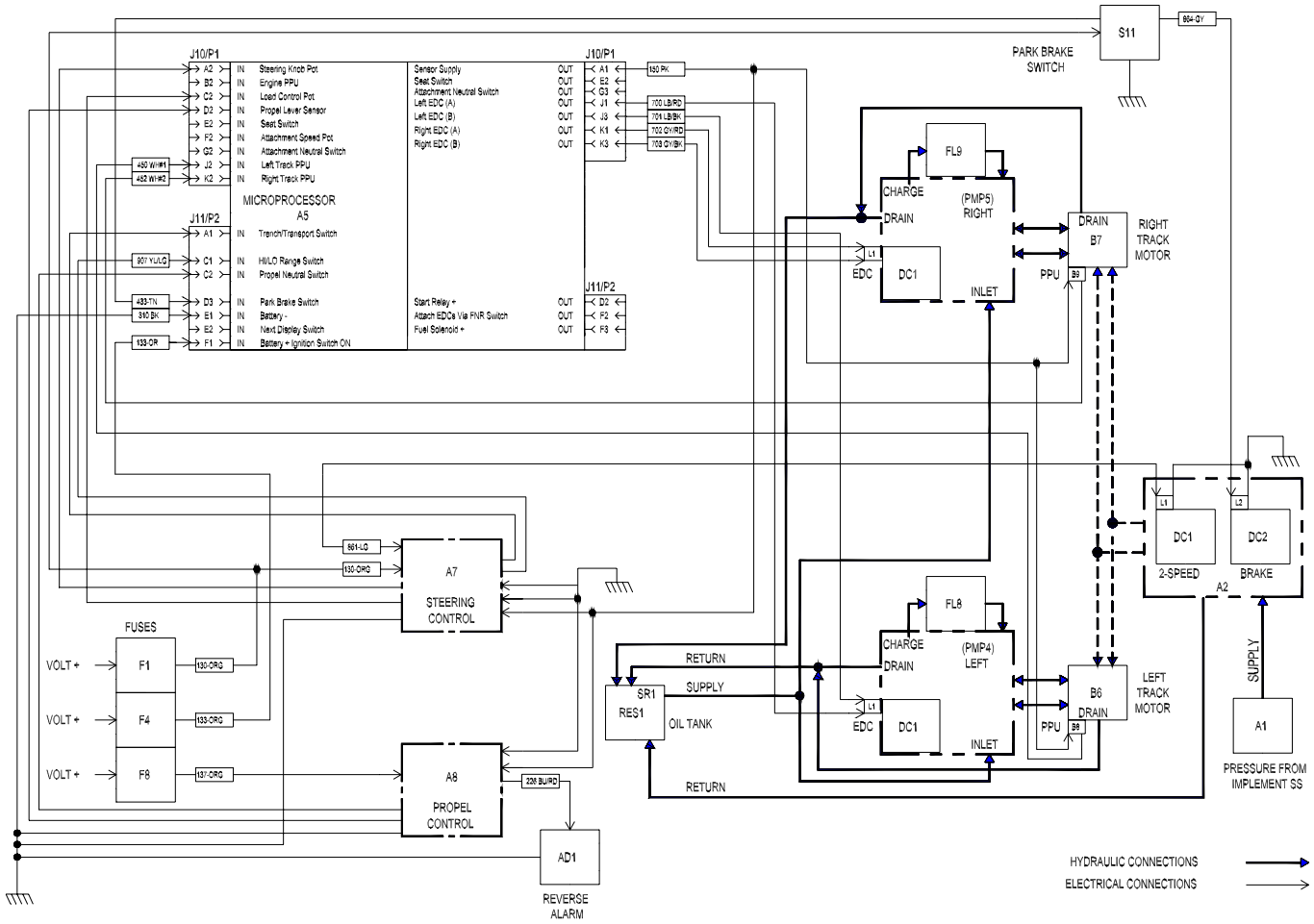
NOTE: The park brake control switch S11 is part of the machine START interlock function. If the engine is shut down and the switch is left in the OFF position, the engine will not start until the switch is turned ON. Refer to Engine subsystem Theory Chapter 5A for more information on the START interlock functions.

Brakes - Released

When switch S11 is turned to the OFF position, the circuit is closed, completing a voltage path to energize the park brake valve solenoid DC2L2 of valve assembly A2. The valve will shift, allowing hydraulic pressure from the implement subsystem control valve to the planetaries to release park brakes.

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Operation - Track Drive Hydrostatic Circuits

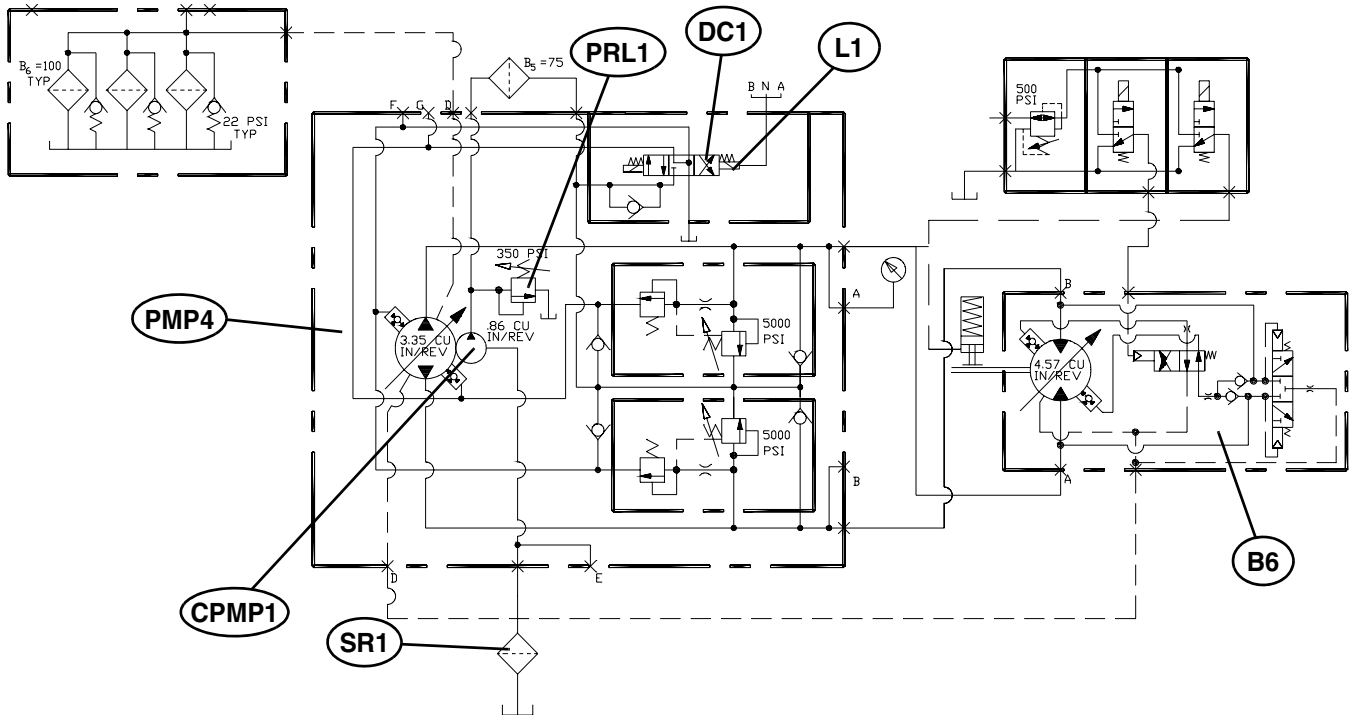


Although both track drives are shown on the map, the following theory of operation will discuss the left track drive function. The left and right track drive circuits are identical in design. The theory of operation for the right track drive circuit would be the same.

Refer to “Operation - Electrical Control Circuits/Components,” **page 7A-7** for detailed propel, steering, and park brake/2-speed control theory of operation.

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Pump PMP4



EDC (Electronic Displacement Control)

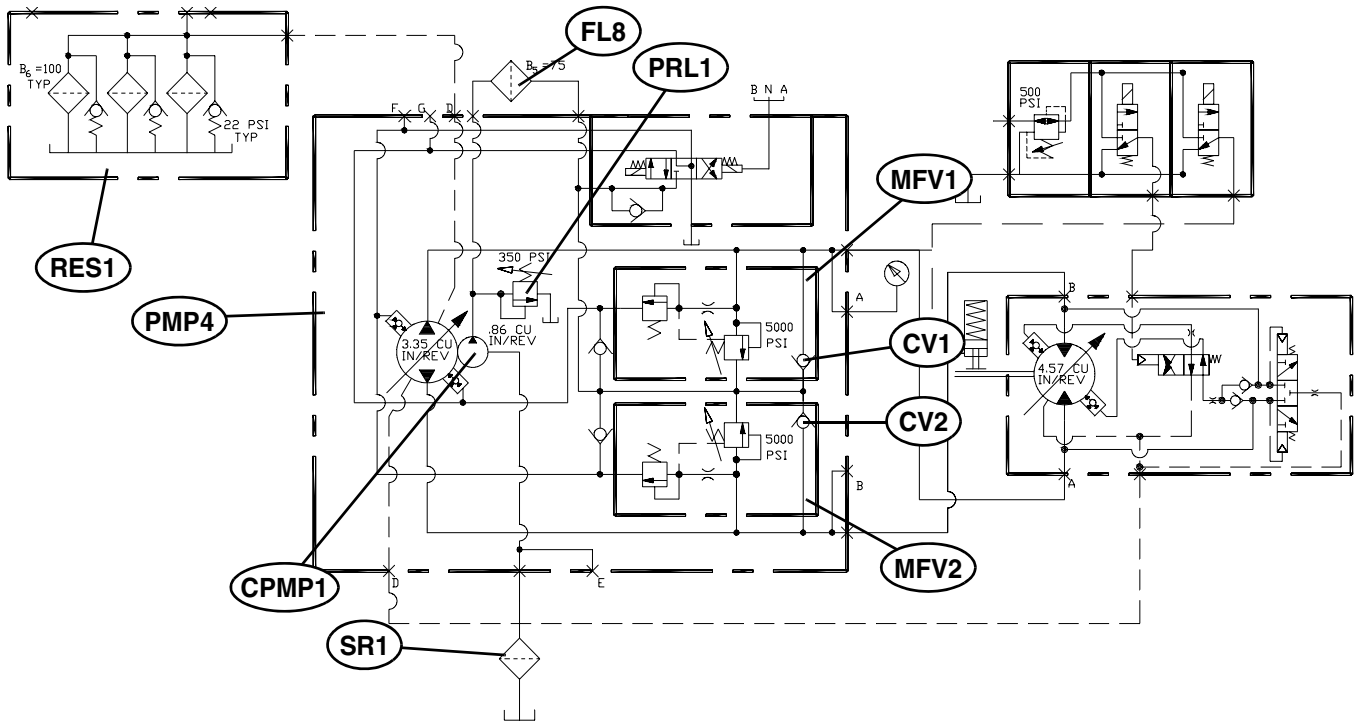
Once the operator actuates the propel control lever, the EDC L1 converts the DC electrical signal from the microprocessor into a hydraulic signal which operates a spring-centered, 4-way directional servo valve DC1 integral to pump PMP4. The valve ports pressurized oil to either side of a dual acting servo control piston. The servo piston rotates the swashplate through an angular rotation of ± 17°, to vary the pump's displacement from full displacement in one direction to full displacement in the opposite direction.

The pump provides oil flow from either the A or the B port to the ground drive motor B6 to allow variable speed, bi-directional operation of the motor.

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Charge Pressure Circuit



A charge pump CPMP1 is installed in the main pump PMP4 and driven off the main pump shaft. The charge pump is necessary to:

- supply cool oil to the system
- maintain positive pressure in the main system loop
- provide pressure to operate the control system
- make up for internal leakage

The charge pressure must be present under all conditions of moving and parking to prevent damage to the system. The charge relief valve PRL1 on the pump serves to maintain maximum charge pressure at a setting of 350 psi (24 bar).

Oil is forced by atmospheric and oil tank pressure through suction screen SR1 installed in the oil tank RES1, to the charge pump CPMP1. The charged oil flows through the low pressure charge filter FL8, through system check valves CV1 & CV2 which are integral to the multifunction valves MFV1 & MFV2, to both sides of the loop. When the closed loop is full of oil, the remainder of oil goes across the charge pressure relief valve PRL1, back to tank.

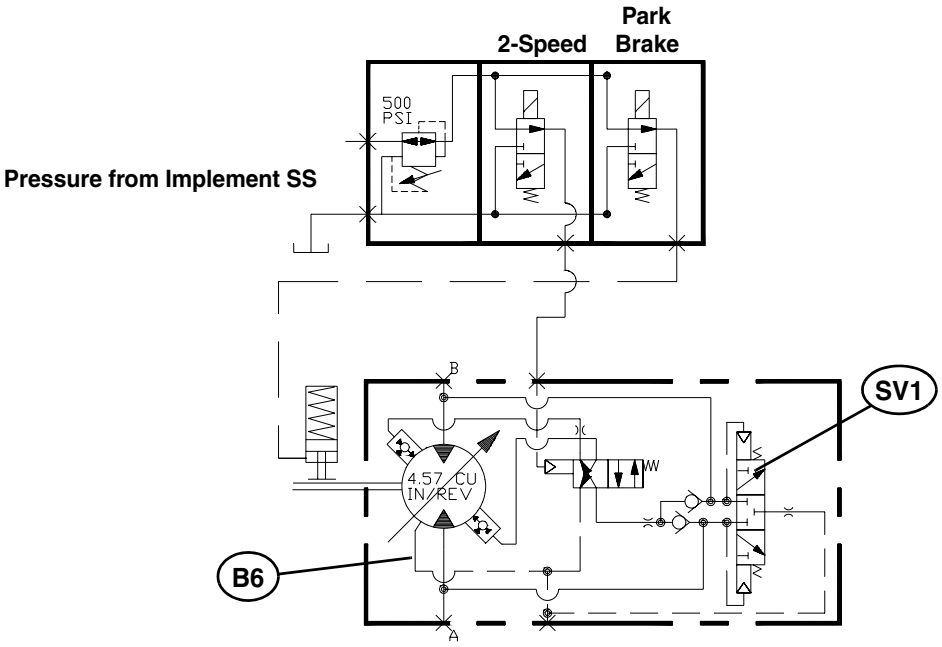
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Multifunction Valves MF1 & MF2

The multifunction valves MFV1 & MFV2 used in each closed loop port, limit system pressure and allow charge oil to keep the closed loop filled. The multifunction valves incorporate the system check valve, high pressure relief valve, and bypass valve in a replaceable cartridge.

When the preset pressure, 5000 psi (345 bar) is reached in the main loop, the high pressure relief valve acts to immediately limit system pressure by cross-porting system flow to the low pressure side of the loop.

Track Drive Motor B6



As soon as the pump swashplate moves off center position, oil flows out of pump, through the high pressure side of the closed loop to the variable-displacement bi-directional motor B6, causing it to rotate. The resistance created by the oil flow through the motor begins to build pressure which in turn causes the shuttle valve SV1 inside motor to shift. The shuttle valve SV1 provides a secondary flow path, on the low pressure side of the closed loop, which allows a percentage of oil discharging from the motor to flow back to the tank for cooling and filtering.

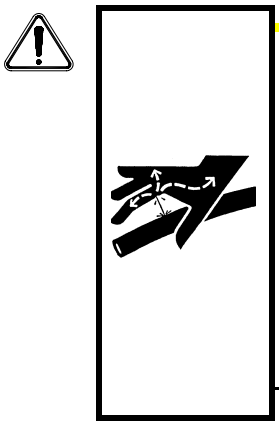
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Chapter 7: Ground Drive Subsystem

Section B: Troubleshooting



WARNING: Pressurized fluid can penetrate body tissue and result in serious injury or death. Leaks can be invisible. Keep away from any suspected leak. Relieve pressure in the hydraulic system before searching for leaks, disconnecting hoses, or performing any other work on the system. If you must pressurize the system to find a suspected leak, use an object such as a piece of wood or cardboard rather than your hands. When loosening a fitting where some residual pressure may exist, slowly loosen the fitting until oil begins to leak. Wait for leaking to stop before disconnecting the fitting. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

OVERVIEW

Pretest Inspection

Before beginning any troubleshooting, review information in the General Information Chapter under *"Troubleshooting Guidelines," page* **1-9**.

If a malfunction occurs, do the following visual checks to inspect for obvious signs of failures before any testing is performed.

- Check for any obvious mechanical failures such as, broken linkages, cables, sprockets, chains, sheaves, pulleys, belts, and so on.
- Check hydraulic oil level in tank, especially if all implement circuits or other subsystems are experiencing similar performance problems.
- Check hydraulic circuits for any obvious failures such as, broken, kinked, loose, or leaking hoses and fittings on supply, pressure, and return to hydraulic components. Also, check for broken, missing, corroded, or loose connections and wires that supply ground and power to electrical components.

Correct any problems found during the inspection. Operate the machine to verify the malfunction is fixed.

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Fault Charts

If no problems were found during the pretest inspection, refer to the fault charts starting on page 7B-3 and continue troubleshooting. The possible malfunctions listed do not cover everything that could go wrong with the circuits. They are meant to give a technician a logical place to begin, based on performance observations.

Test Equipment Needed

IMPORTANT: The pressure and flow ratings of the test equipment used to conduct the following hydraulic test procedures must be equal to, or greater than the pressure and flow ratings of the circuit being tested.

- Pressure Gauge
- Vacuum Gauge
- Phototachometer
- Flow Meter
- Pyrometer
- Digital Multimeter

Component Repair/Replace

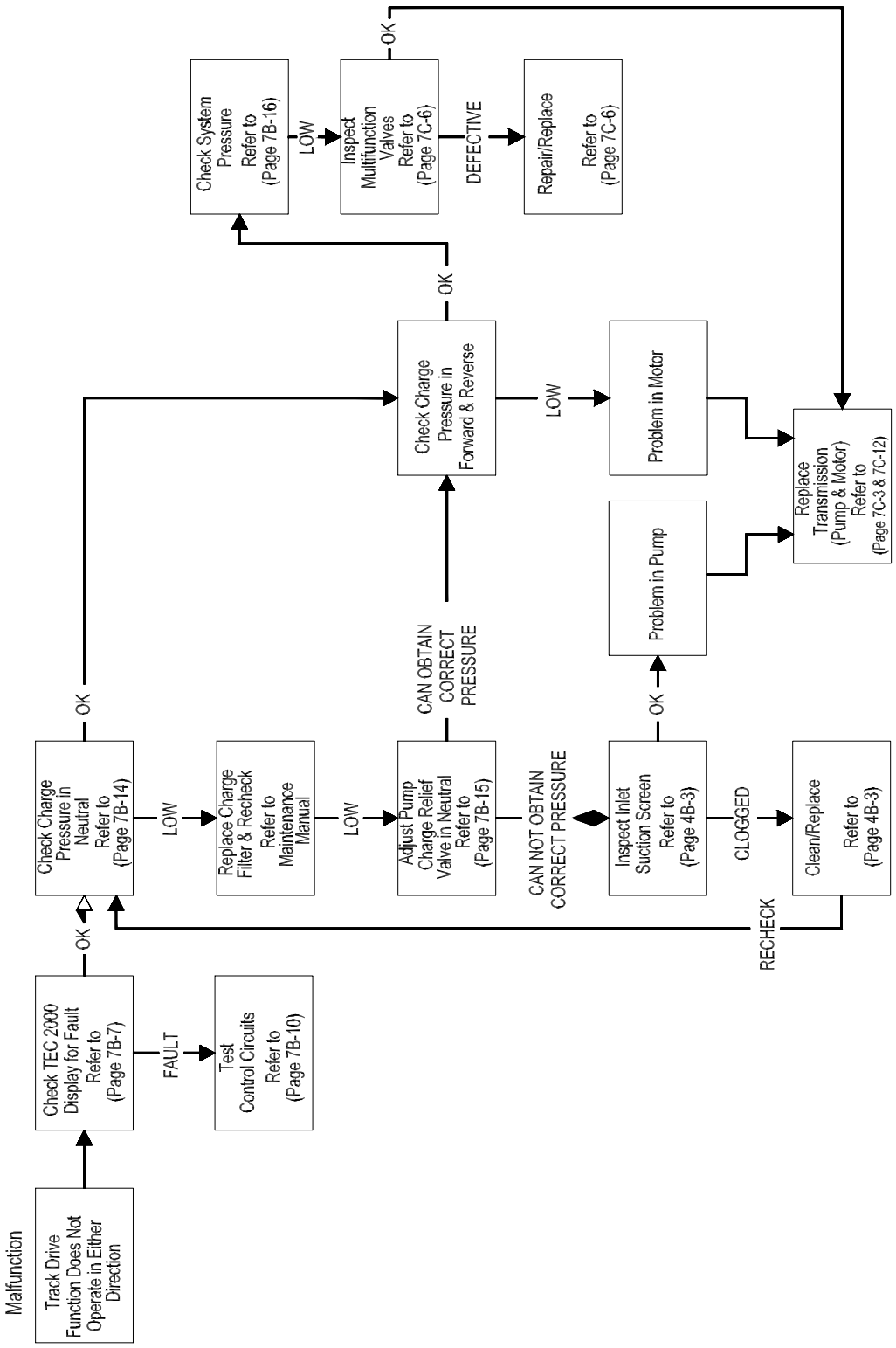
If troubleshooting procedures determine a component is in need of repair or replacement, refer to section C for the appropriate repair procedures for those components.

NOTE: If the machine requires moving to troubleshoot or repair, it is possible to open bypass valves on the track drive pumps to move (tow) the machine. Refer to page 7B-17 for information on how to bypass the pumps.

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FAULT CHARTS

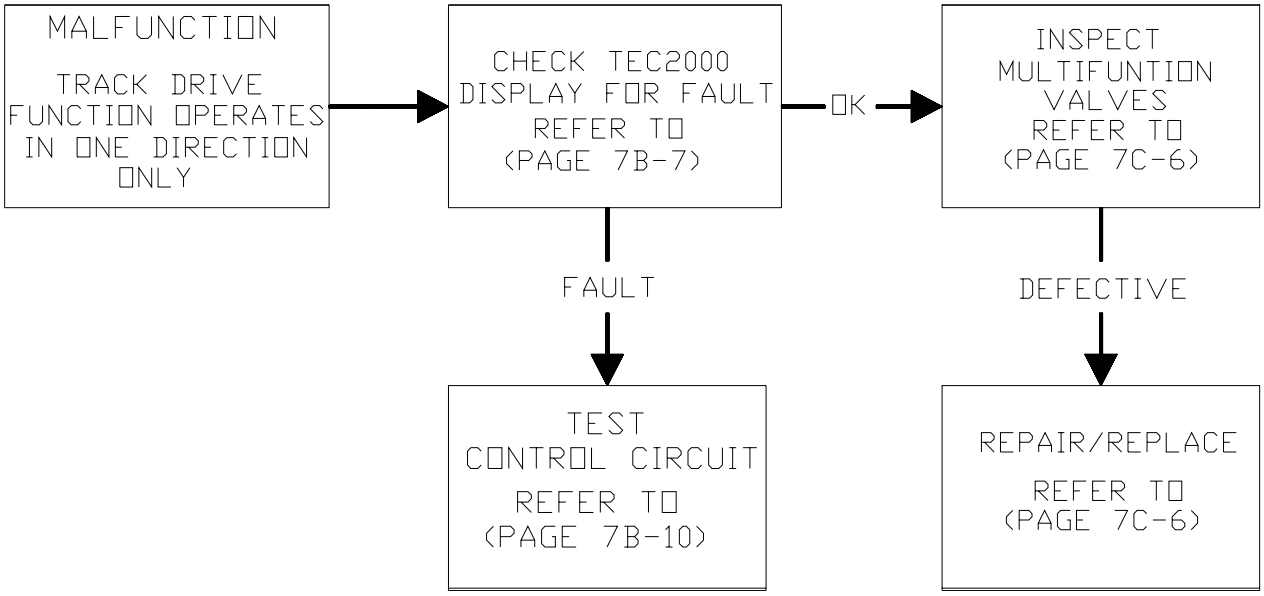
Track Drive Function Does Not Operate in Either Direction



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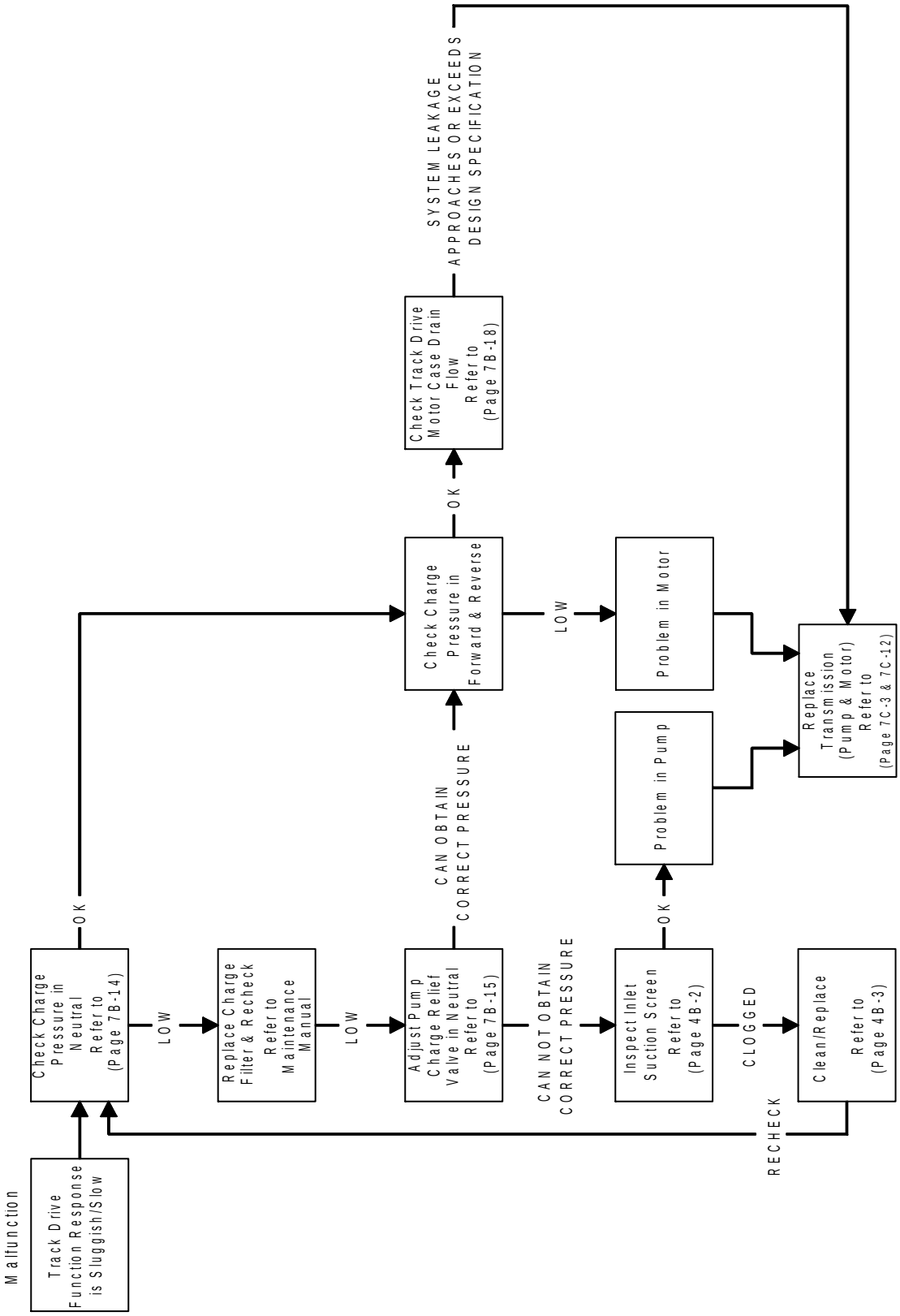
Track Drive Function Operates in One Direction Only



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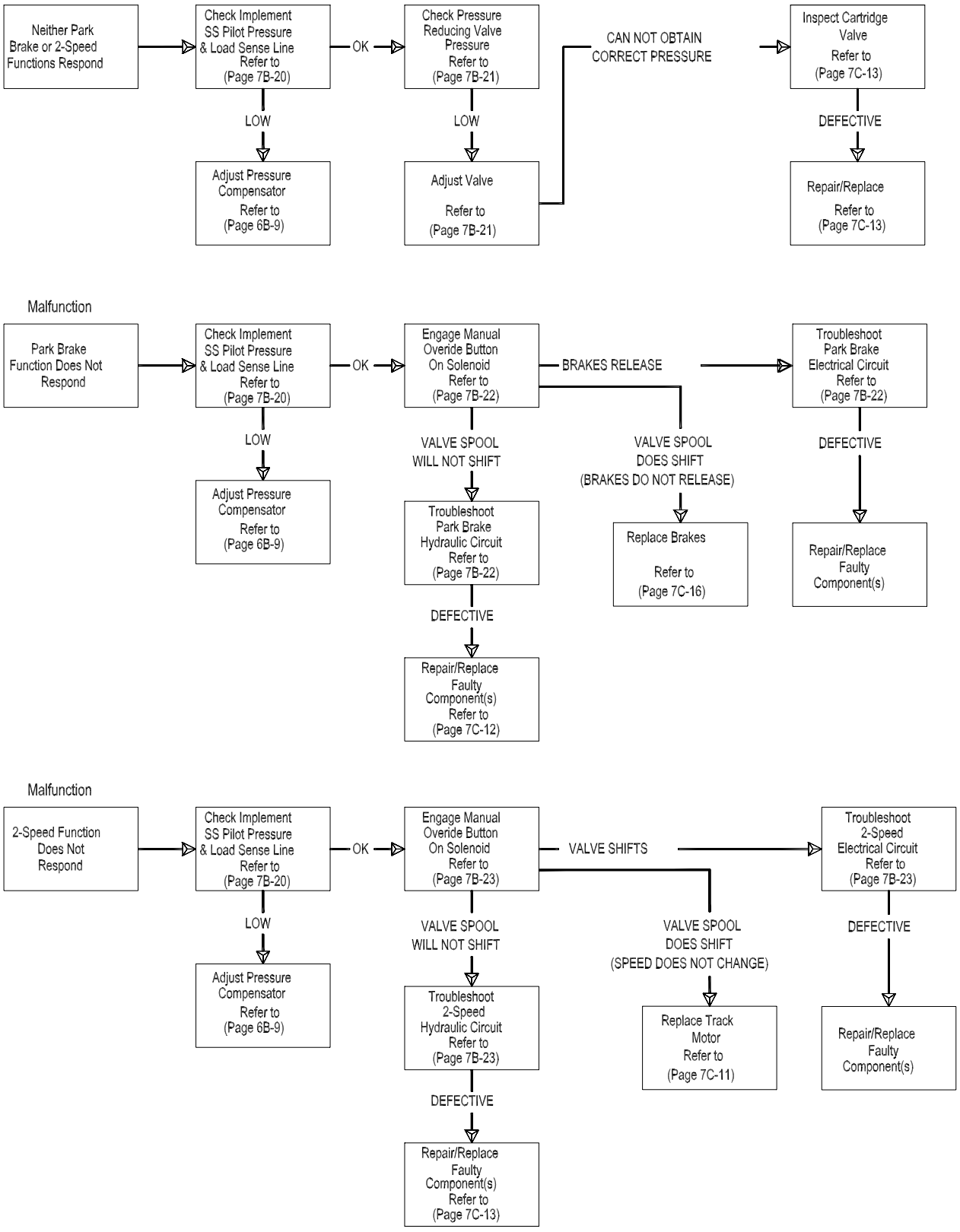
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Track Drive Function Response is Sluggish/Slow in Both Directions



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Park Brake & 2-Speed Circuits



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LEFT AND RIGHT TRACK DRIVE CIRCUITS

Electrical Control Circuits/Components

Both track drive circuits are controlled using the various electronic control modules, sensors, and switches, as well as the microprocessor (TEC 2000). The MAP on page 7B-10 shows the relationships of the ground drive control circuits and components. The lines and arrows represent the inputs and outputs to and from each component.

TEC 2000 Microprocessor

The TEC 2000 microprocessor view screens display information received from inputs and outputs of the various electrical control components. The view screens indicate the current operating parameters for voltage, amperage and RPM. When a parameter is out of range, the microprocessor will display a fault to indicate a control is malfunctioning. The various faults associated with the ground drive control circuits are listed below.

Troubleshoot the appropriate control circuits/components according to the faults experienced. On page 7B-8 is a troubleshooting table listing some general areas to check when troubleshooting.

Display Faults

TEC 2000 FAULTS	DESCRIPTION
SENSOR POWER	Measured sensor power voltage is not within 4.75V to 5.25V.
PROPEL POT	Propel Lever Pot reading is more than 0.1V outside the calibrated range (full reverse to full forward).
NEUTRAL SWITCH OUT OF RANGE	Propel Lever Sensor voltage reading is outside of calibrated ″NEUTRAL Deadband″ when FNR is in neutral (based on neutral switch) or propel lever sensor voltage is outside of calibrated NEUTRAL band when FNR is not in NEUTRAL.
STEERING POT	Steer Pot reading is more than 0.1V outside the calibrated range (left stop to right stop).
ENGINE LOAD POT	Trencher Speed Pot reading is more 0.1V outside the calibrated range (left stop to right stop).
ENGINE PPU LOST SIGNAL	Measured Engine RPM is 0 rpm but either left or right measured motor speed and the corresponding valve current are non-zero.
LEFT EDC SHORT CIRCUIT	Left EDC Coil Resistance is less than 5 Ω. The check is only done when there is current commanded.
LEFT EDC OPEN CIRCUIT	Left EDC Coil Resistance is greater than 40 Ω. The check is only done when there is current commanded.
RIGHT EDC SHORT CIRCUIT	Right EDC Coil Resistance is less than 5 Ω. The check is only done when there is current commanded.
RIGHT EDC OPEN CIRCUIT	Right EDC Coil Resistance is greater than 40 Ω. The check is only done when there is current commanded.

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Troubleshooting Table

Use the table below for indications on where to test the circuits. Refer to the following pages for information on testing the control circuits. Use the map and wire harness diagram for reference when testing.

TEC 2000 FAULTS	TROBLESHOOTING CHECKS
SENSOR POWER	Usually caused by a potentiometer being shorted to ground. • Check battery voltage. • Check wiring harness. • Check connections coming from the battery voltage to the microprocessor for shorts or opens. • Check voltage supply line coming into the microprocessor.
PROPEL POT	• Display propel lever view screen and look for a voltage change while moving the lever. This will ensure voltage signal to microprocessor (normal range 1.5–3.5V). • Check connection between propel lever and microprocessor. • Remove propel lever, look for faulty wiring, broken or loose parts or a faulty potentiometer.
NEUTRAL SWITCH	• Display propel lever view screen and look for a voltage change while moving the lever. This will ensure voltage signal to microprocessor (normal range 1.5–3.5V). • Recalibrate propel lever. • Check connections between propel lever and microprocessor. • Remove propel lever, look for faulty wiring, switch, or a faulty potentiometer.
STEERING POT	• Display steering view screen and look for a voltage change while turning the steering knob. This will ensure voltage signal to microprocessor (normal range 0.5–4.5V. • Check connection between steering control box and microprocessor. • Check steering control and look for faulty wiring or potentiometer.

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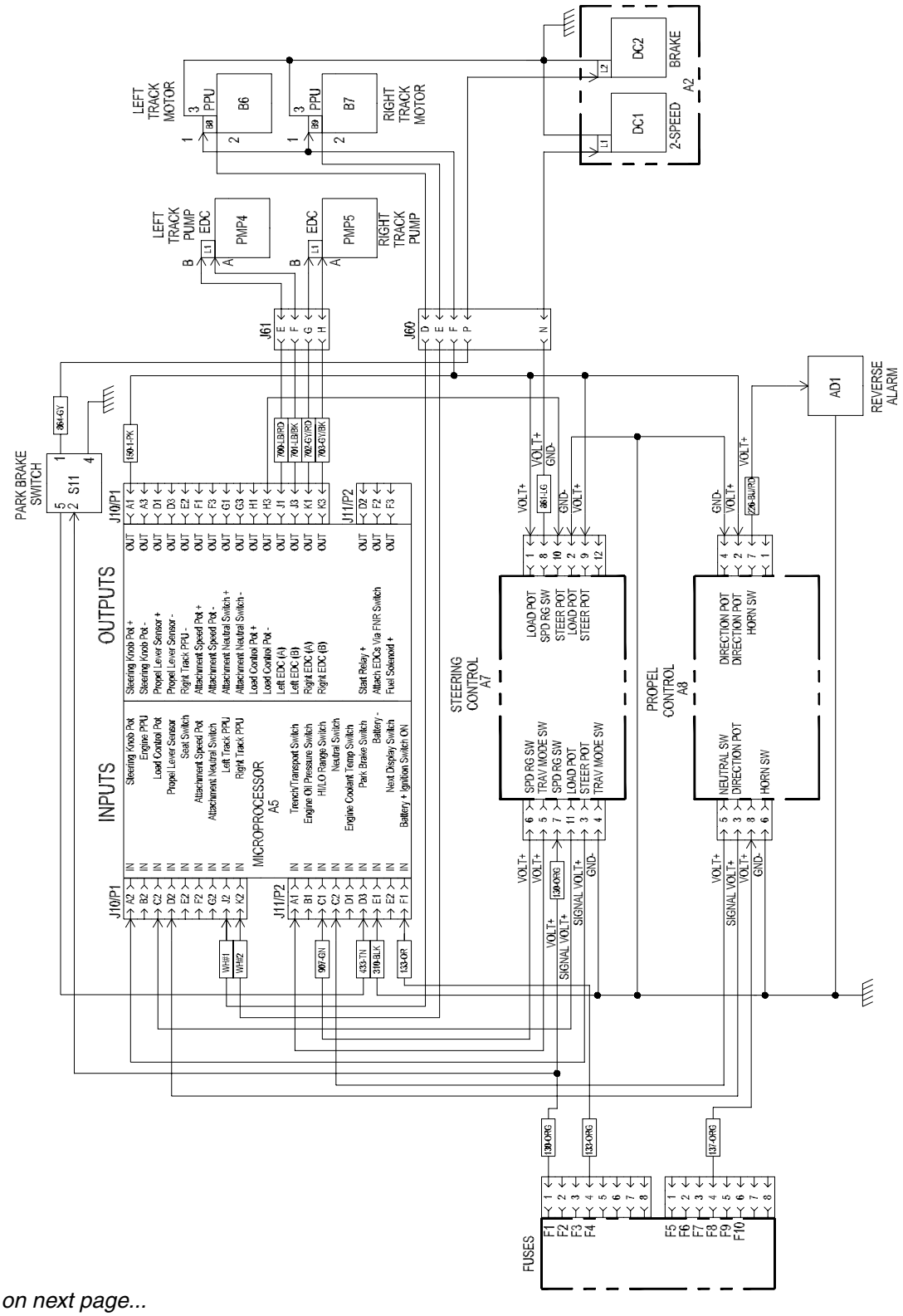
NOTE: Left and right PPU faults do not initially appear on the display screen and must be retrieved from the fault log. Refer to *"Fault Screens," page* **2-20** for information on navigating through the faults. Refer to page **7B-13** for information on adjusting the PPUs.

TEC 2000 FAULTS	TROBLESHOOTING CHECKS
ENGINE LOAD KNOB	• Display engine load knob view screen and look for voltage change while moving the engine load knob. This will ensure voltage signal to microprocessor (normal range 0.5–4.5V). • Recalibrate engine load knob. • Check connection between engine load knob and microprocessor. • Check engine load knob control and look for faulty wiring or potentiometer.
ENGINE PPU	• Check engine PPU and connector. • Check PPU gap to engine flywheel is one half turn. • Check wiring from PPU to microprocessor.
LEFT OR RIGHT TRACK PPU	This will not appear on screen (retrieved from fault log). • Check PPU gap (refer to PPU install chart). • Check wiring from PPU to microprocessor.
LEFT OR RIGHT EDC SHORT	• Check for short between EDC and microprocessor. • Check for short in EDC.
LEFT OR RIGHT EDC OPEN	• Check for broken wire or loose connection (open) between the EDC and the microprocessor.

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Testing Control Circuits

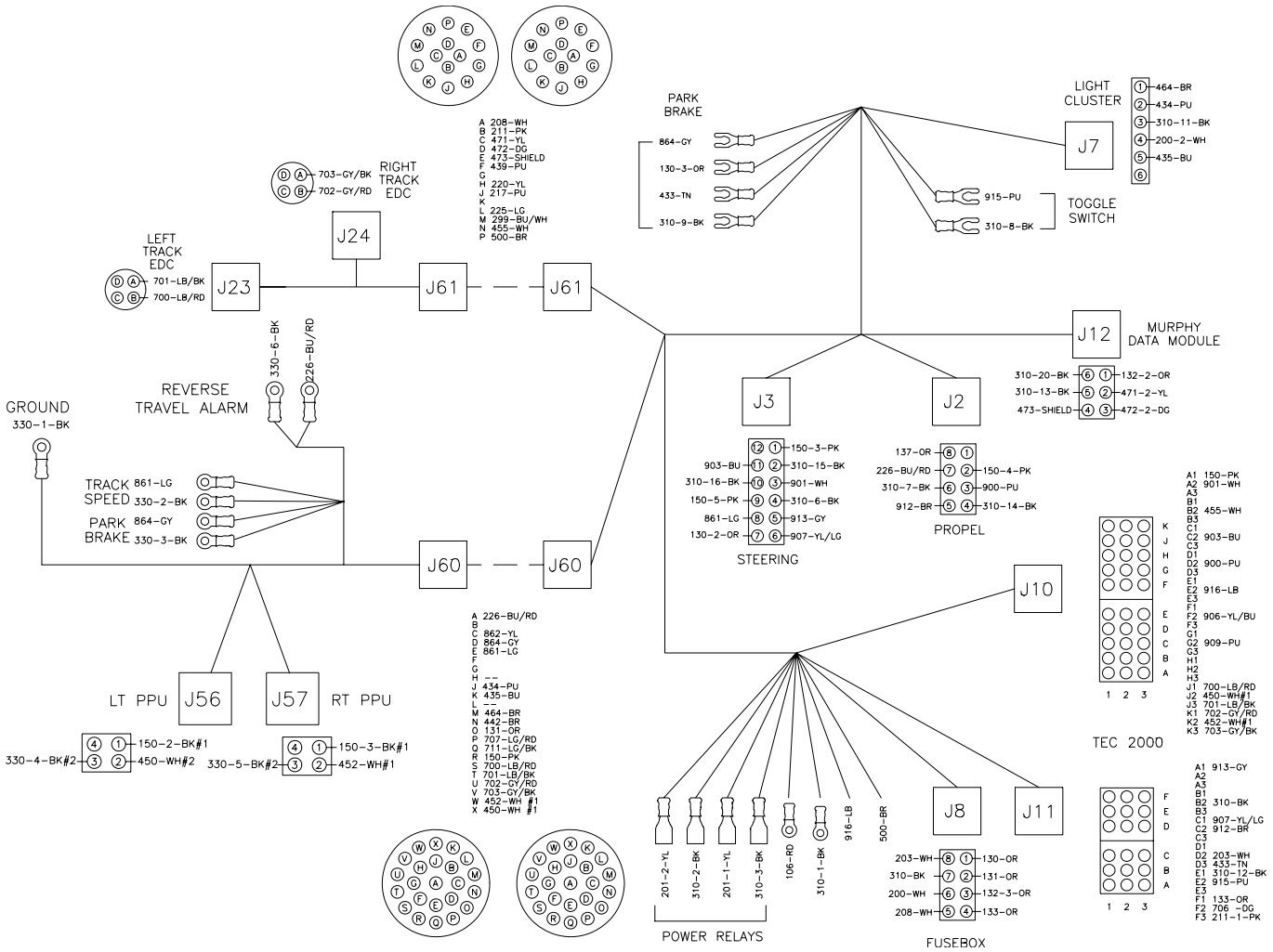
Control Circuits
MAP



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Component Pin/ Terminal Reference



The diagram above represents the wire harness connections of the ground drive control circuits components. Use the diagram for pin, terminal, wire, and plug reference when testing circuits and components. Only the wire harness connections relevant to the ground drive control circuits are represented.

Complete wire harness diagrams and schematics are located in the Addendum section at the back of the manual if needed for reference. For detailed information on the TEC 2000 microprocessor pin designations and functions, refer to Chapter 2 System Information.

The following procedures are used to test for opens, shorts or high resistance in the circuit. Compare test results with the normal parameters listed in the troubleshooting table on page **7B-8**. If component(s) are not within the normal parameters given, they need to be repaired or replaced.

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Open Circuit Test

1. Test for an open in the circuit by testing for acceptable voltage on input and output pins/terminals of plugs and components. The control circuits MAP on page 7B-10 illustrates what the TEC 2000 microprocessor is inputting and outputting to and from the circuits. Testing at these points, working through the circuit, will isolate the failed component(s) by process of elimination. Continue through the circuit until the open is found.

   Expected result: When the positive lead is placed before an open point, the meter will read voltage. When the lead is placed beyond the open, the meter will read no voltage, indicating that a complete circuit exists from the chassis ground to the point where voltage is last measured in the circuit.

2. Once the open is found, turn ignition switch OFF, unplug wire harness at the suspected component and test component for continuity or specified resistance. If the component is OK, test wires, plug connections, connecting the component for continuity. Replace faulty component or section of wire harness. If voltage is measured at all test points, continue next by measuring for voltage on ground side.

3. Normal voltage should measure 0.0–0.5 volts. If battery voltage is measured on ground side, a poor connection or broken wire/cable is indicated. Test wires connecting the component for continuity. Replace faulty section of wire harness.

High Resistance Test

Measurements taken from a multimeter can be used to troubleshoot for unwanted resistance. Use multimeter to test for lower than normal battery voltage (voltage drop) while moving to accessible points in the circuit wiring. Replace section of failed wire harness. Refer to the diagram on previous page.

Short Circuit Test

1. Test for a short in the circuit. When testing the circuit for a short, turn the ignition switch OFF and set the multimeter to measure resistance (ohms). Work through the circuit. If the meter measures resistance through the complete circuit, it may be an intermittent problem causing the short. In that case, repeat procedure and move wiring harness or tap on components while watching for a sudden drop in resistance (Ω).

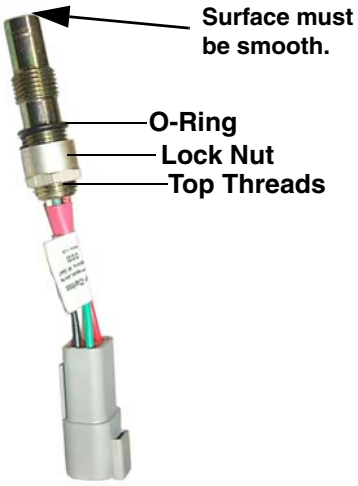
   Expected result: If the voltage side of the circuit is shorted to ground, the meter will read 0.0 Ω This indicates there is no resistance between check points (a dead short). Work through the circuit until the short is located. When the short is removed, the meter will return to a resistance reading.

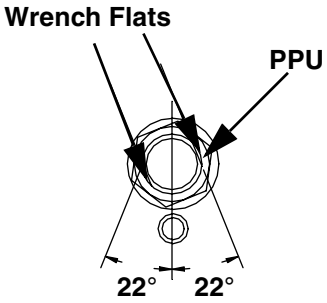
2. Repair or replace faulty component or section of wire harness. Check circuit for function.

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Track Motor PPUs

1. Push F2 button on the microprocessor.
2. Push toggle switch until the display is track motor speeds L = RPM R = RPM. Move trencher forward without turning and see which side is not registering RPM. That will be the side with the problem with either the PPU, wiring, or computer.
3. Remove and visually inspect PPU for damage. If the PPU surface is not smooth, the PPU is bad. If no damage is evident, test the continuity of the PPU. If OK, install the PPU and adjust according to the instructions below. If not OK, replace and adjust new PPU according to instructions below. If the problem persists, continue with Step 4.
4. Test PPU circuits for opens, shorts and high resistance. Refer to page 7B-12 for instructions.





PPU - Install/Adjust

1. Back off the lock nut and push O-ring up as far as possible.
2. Apply a light film of oil to the O-ring and by hand, turn PPU clockwise until it contacts the speed pickup ring.
3. Turn PPU counterclockwise 1/2 turn.

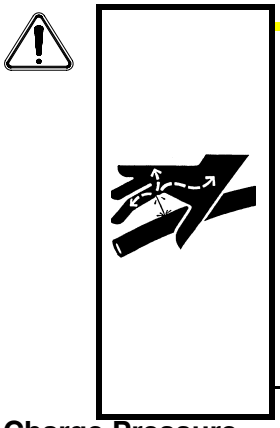


NOTE: Many wrenches have a 22° handle offset

4. Turn PPU clockwise until wrench flats are positioned at a 22° angle to the motor shaft centerline. PPU position should be between 1/2 turn and 1/4 turn counterclockwise from point of where the PPU contacts the speed pickup ring.
5. While holding the PPU body with a 1/2″ wrench, tighten lock nut with a 11/16″ wrench. Torque lock nut to 10 ft-lb (13 Nm).

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Track Drive Hydrostatic Circuits



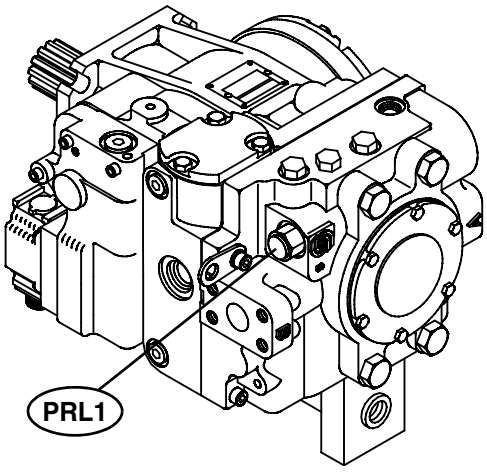
WARNING: Pressurized fluid can penetrate body tissue and result in serious injury or death. Leaks can be invisible. Keep away from any suspected leak. Relieve pressure in the hydraulic system before searching for leaks, disconnecting hoses, or performing any other work on the system. If you must pressurize the system to find a suspected leak, use an object such as a piece of wood or cardboard rather than your hands. When loosening a fitting where some residual pressure may exist, slowly loosen the fitting until oil begins to leak. Wait for leaking to stop before disconnecting the fitting. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

Charge Pressure

The pressure in the hydrostatic system must be known to quickly and accurately troubleshoot the system. Diagnostic fittings located on the side of the machine are provided to check various pressures.

Insufficient charge pressure will result in inadequate or poor track drive performance.

The charge relief valve PRL1 on the pumps serve to maintain charge pressure at the specified setting. This normal setting assumes the pumps are in NEUTRAL (zero flow); in FORWARD or REVERSE charge pressure will be slightly lower.



Charge Pressure - Check

Snubbers are recommended to protect the pressure gauges. Gauge calibration is necessary to ensure accurate readings. A diagnostic pressure gauge, part number 67566001, is available from Vermeer. This is a 2-stage pressure gauge rated for 7500 psi (520 bar).

To check the charge pressure of a track drive system:

1. Install pressure gauges capable of at least 500 psi (35 bar) in the left and right track drive pump charge pressure diagnostic gauge ports located on the side of machine.
2. Start engine and set throttle speed to (2200 rpm)
3. Ensure propel handle is in NEUTRAL.
4. Ensure park brake switch is ON.
5. Ensure hydraulic oil is warmed to at least 100°F (38°C).

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6. Observe gauges in NEUTRAL.

   Expected result: The diagnostic pressure gauges should read 350 psi ± 10 (24 bar ± .7).

7. If charge pressures are not within specification, replace remote charge filter(s) Refer to the T655III *Maintenance Manual for* instructions on replacing filters.

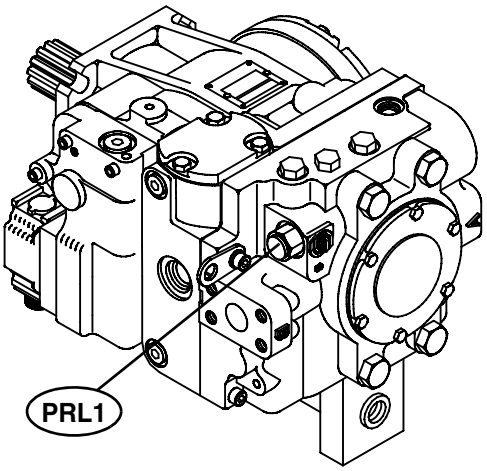
8. Recheck charge pressure. If pressure is still too low, adjust charge pressure while in NEUTRAL. See below. If charge pressure is correct, remove the park brake fuse then move the propel handle out of NEUTRAL and check the FORWARD and REVERSE pressure.

   Expected result: The pressure should drop to 300 psi ± 20 (21 bar ± .6). If charge pressure is OK in NEUTRAL but not in FORWARD or REVERSE, most likely there is a problem in the motor.

   If the malfunction was a sluggish or slow running track drive and the charge pressures are OK in NEUTRAL, FORWARD, and REVERSE, refer to the Track Drive Motor Case Drain Flow Test page **7B-18** to determine if the closed-loop transmission is worn beyond design specification.

Charge Pressure - Adjust

1. Adjust by loosening the hex nut of pressure relief valve PRL1 of the appropriate pump. Turn adjustment screw clockwise to increase pressure, counterclockwise to decrease pressure.



2. If correct charge pressure cannot be obtained through adjustment, refer to page **4B-2** of the Fluid Conditioning subsystem and inspect the suction screen. If clogged, clean or replace screen.

3. If the suction screen is OK, most likely there is a problem in either the charge pump or charge relief valve.

4. Follow *"Shutdown Procedure," page* **2-1**.

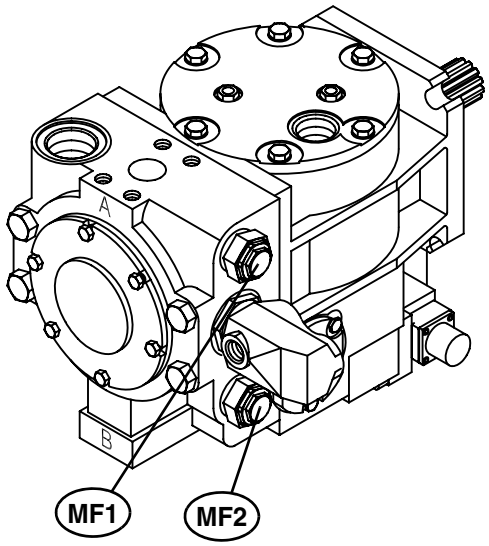
5. Remove pressure gauges.

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System Pressure

Multifunction valves MF1 & MF2 located on the pumps are used to set the system high pressure limit. Adjustment of pressure limiter setting and high pressure relief setting is accomplished simultaneously. The high pressure relief valve is set approximately 500 psi (35 bar) above the pressure limiter assembly.

NOTE: The valves are set at the factory and should not need adjusted unless they are repaired or replaced with new ones. Refer to page 7C-6 for information on adjusting.



System Pressure - Check

Track drive system pressure can be monitored with the pressure gauges in the control panel.

1. Remove park brake fuse and turn park brake ON.
2. Start engine and set engine speed to full throttle.
3. Place track speed range switch in trench (low speed) and travel mode switch to trench mode.
4. With the propel lever in NEUTRAL, the track pressure gauges on control panel should read charge pressure 350 psi ± 10 (24 bar ± 0.7).
5. Push propel handle to FORWARD so pressure increases in the high pressure side of the closed circuit to the pressure limiter setting. The pressure limiter setting is reached when pressure stops increasing and remains steady as shown on track pressure gauges.

   Expected result: The pressure gauges should measure approximately 5000 psi (345 bar). If not, return pump to its NEUTRAL setting, (zero flow) position. Refer to page 7C-5 of repair section and inspect multi-function valves for damage or contamination and repair or replace and adjust as necessary.

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Towing

Bypass valves built into the multifunction valves can be operated when it is desired to move machine short distances when pumps are not operating. Opening bypass valves allows flow to circuit through multifunction valve.

Bypass valves on both multifunction valves must be open to engage bypass function.

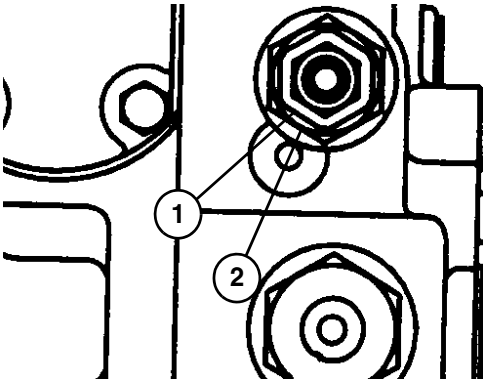
NOTE: This procedure is meant for towing onto a trailer, towing a distance can cause excessive heat and stress to the system.

NOTE: To tow the machine, the bypass valves must be released manually and the brakes must be released either by implement pump pressure or manually if pump pressure is not available.

Releasing Bypass Valves

Release bypass cartridges **(1)** in both track drive pumps.

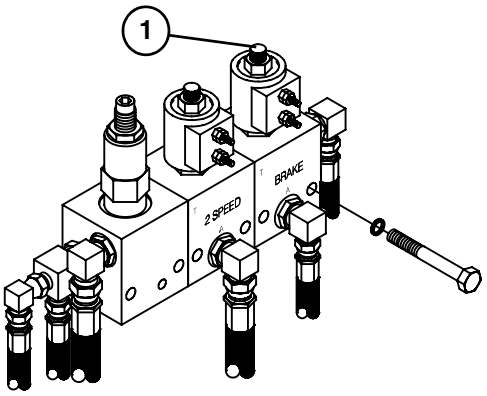
1. Follow *"Shutdown Procedure," page* **2-1**.
2. Use a wrench on middle-sized hex **(1)** of multifunction valve cartridge, and another wrench on the large hex **(2)** to prevent rotation of cartridge assembly. Rotate middle hex three revolutions counterclockwise to open bypass valve. Do not rotate more than 3-1/2 revolutions, as additional rotation will permit external leakage.



3. Release park brake.

Releasing Park Brakes

4. Start engine and set park brake switch to the open (OFF) position. If the engine can run and implement hydraulic pump functions, the park brake may be released by using the manual override **(1)**. If engine or hydraulic system does not operate, use a hydraulic porta-power to release parking brakes, AFTER bypass cartridges have been released.



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5. Remove 1/4″ hose “P” port of valve.
6. Attach porta-power to “P” port, this will ensure that pressure is introduced through the pressure reducing valve. Brake cavity can not exceed 500 psi (34) bar, which is the reducing valve setting.

Restoring System

7. After the machine has been towed, close bypass valves by turning clockwise.
8. Carefully remove brake release hose.
9. Connect pressure hose to solenoid valve.

Track Drive Motor Case Drain Flow Test

If a track drive circuit response is sluggish, slow, or running hot but otherwise working, the motor, pump, or both may be worn beyond their useful life or contamination may have prematurely caused the components to wear beyond design specification.

Oil Sampling

A closed-loop system should not be opened when testing so no additional contamination is introduced into the system. Therefore, before installing any test equipment to determine component wear, the first step would be to obtain an oil sample from the closed loop.

Oil sampling systems can analyze the oil without interrupting machine operation or opening the system. The oil sampling system can determine oil viscosity, temperature, particle size, type, and concentration of contamination.

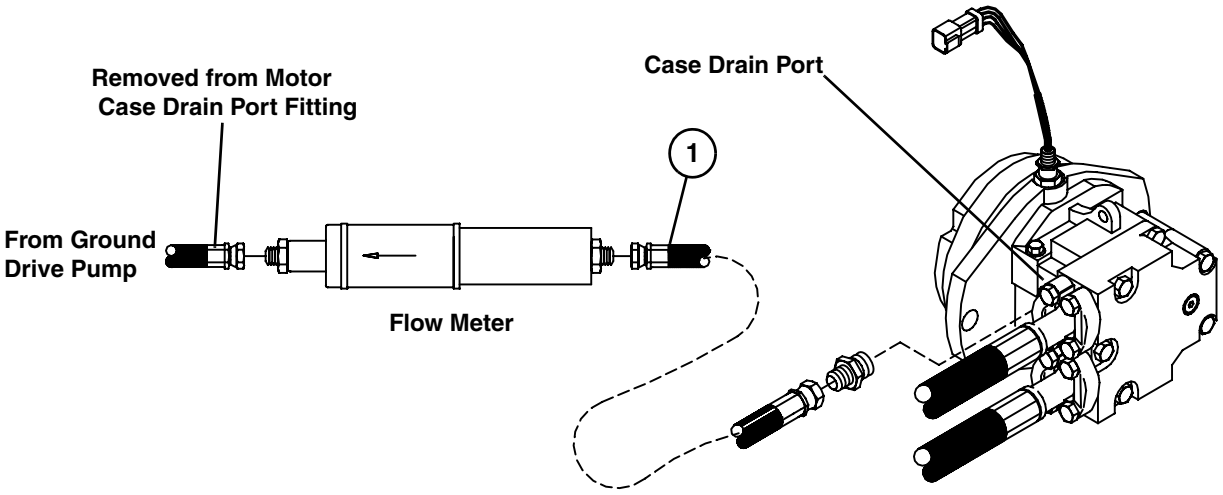
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1. Refer to page 4B-5 of the Fluid Conditioning subsystem Troubleshooting section for oil sampling criteria and procedures. If oil sample test is not within the acceptable range, follow instructions given. If the oil sample test is within the acceptable range, continue with step 2 and test the condition of the closed-loop transmission by measuring the motor case drain flow for excessive leakage.
2. Shut down engine.
3. Turn ground disconnect switch to the DISABLE position.

IMPORTANT: Ensure any hoses or fittings that are added to the test equipment are the same size and rating as hoses and fittings installed in the hydraulic circuit. Mismatched hose or fitting sizes can result in erroneous pressure indications. Mismatched pressure ratings can result in leakage or personal injury.

The test procedure shown is for the left track drive hydrostatic motor. The procedure would be the same if testing the right track drive motor.



4. Remove existing case drain line from motor and install it to the outlet of a 20 gpm flow meter. Ensure meter direction arrow is pointing away from the motor.
5. Add a short hose **(1)** from the case drain port of the motor to the inlet of the flow meter.
6. Secure meter to the machine so it does not come in contact with the tracks when moving. Ensure it is positioned where the operator can view during test.

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7. Turn ground disconnect switch to the ENABLE position. Start engine and inspect test equipment connections for leaks.
8. Allow system to warm up to approximately 130°F (54°C). If needed, cycle a machine function to aid in warming the oil.
9. Set engine speed to full throttle (2350 rpm) on TEC 2000 LCD display. Place track speed range switch in trench (low speed) and travel mode switch to trench mode.
10. Actuate propel control to full FORWARD and record case drain measurement.

Analyzing Motor Test Results

Expected result: The case drain flow measurement should measure between 4 gpm (15 L/min) nominal, to 11 gpm (42 L/min) maximum. If the measurement approaches or exceeds the maximum allowable leakage, it is considered worn beyond its useful life.

IMPORTANT: Motor wear is caused by contamination in the oil and degradation of the oil. Since the pump and motor in the closed loop continuously recycle the same oil, the pump and motor wear at the same rate. If leakage in a motor approaches or exceeds the design specification, it is highly recommended that the transmission (motor and pump) be replaced.

11. At conclusion of test procedure, remove test equipment and reconnect hydraulic lines to the original fittings.

Park Brake and 2-Speed Circuits

The park brake/2-speed circuits are electrically controlled and hydraulically operated. The valves operate using pilot pressure from the Implement subsystem. If pilot pressure is too low, there will not be sufficient pressure to operate the circuits.

To check the Implements subsystem pilot pressure:

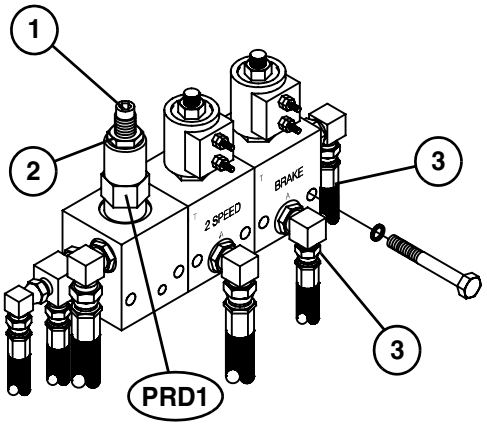
- Install a pressure gauge in the implement pressure diagnostic port located on the side of machine. Start engine and allow the system to warm up. The implement pressure should indicate a maximum of 400 psi (28 bar). If not, refer to page 6B-9 and ensure implement pump low-pressure compensator setting is correct.
- Ensure load sense line **(4)** is not obstructed or damaged.

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Pressure Reducing Valve

The valve is factory set to 500 psi (34 bar). If the pressure reducing valve pressure is too low, it could affect brakes or 2-speed functions. Check, the valve pressure setting.



To check and adjust pressure:

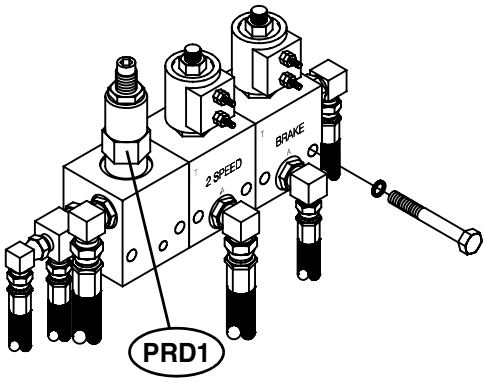
1. *Follow "Shutdown Procedure," page* **2-1**.
2. Turn ground disconnect switch to the DISABLE position.
3. Install a pressure gauge in parallel with the connector at the brake circuit output line **(3)**.
4. Turn ground disconnect switch to the ENABLE position. Start engine and allow the system to warm up. Inspect test equipment connections for leaks.
5. Turn park brake switch OFF and set engine speed to 2350 rpm.
6. Actuate and deadhead the boom lift cylinders. The pressure gauge should indicate a maximum of 500 psi (34 bar). If not, adjust pressure.
7. Loosen retaining nut **(2)**.
8. Using a Allen wrench, turn adjustment screw **(1)** clockwise to increase pressure to 500 psi (34 bar). If correct adjustment cannot be obtained, continue.
9. *Follow "Shutdown Procedure," page* **2-1**.
10. Turn ground disconnect switch to the DISABLE position.

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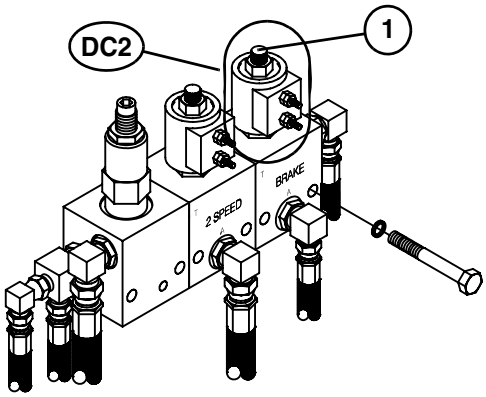
NOTE: Contaminants in hydraulic oil, over a period of time, can build up between moving parts and housings and cause the valve spool to stick. Leaking O-ring seals and backup washers can also affect the output flow of the valve.

11. Remove, inspect, and clean cartridge valve components PRD1. Replace any faulty seals or O-rings that may be found. Refer to page 7C-13 of repair section for information.



Park Brake Circuit

If the brakes do not release when the park brake switch is turned OFF, either the electrical circuit is faulty, the valve spool is stuck, or there is not adequate pressure.



1. Ensure there is adequate pilot pressure. Refer to page 7B-21. If pressure is OK, continue.

NOTE: The manual override should only be used when troubleshooting the park brake circuit.

2. Activate manual override button **(1)** by pressing down and turning counterclockwise.

Expected result: The valve spool should shift releasing the brakes. If so, the problem is electrical. Continue testing the electrical circuit. See following page. If spool will not shift, test hydraulic circuit. See following page. If spool does shift, but brakes do not release, the problem may be internal to the planetary. Most likely the brakes have failed. Replace brakes.

NOTE: The brakes are non-adjustable and must be replaced as a unit. Refer to page 7C-16 of repair section for information.

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Electrical Troubleshooting

The electrical procedures are used to test for opens, shorts or high resistance in the park brake circuit. Refer to page 7B-10 for circuit diagrams and test procedures.

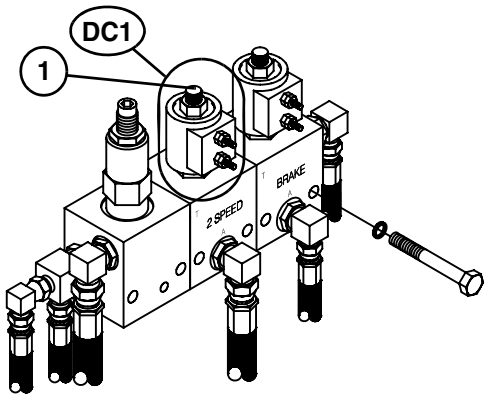
Hydraulic Troubleshooting

NOTE: Contaminants in hydraulic oil, over a period of time, can build up between moving parts and housings and cause the valve spool to stick. Leaking O-ring seals and backup washers can also affect the output flow of the valve.

- Remove, inspect, and clean cartridge valve components DC2. Replace any faulty seals or O-rings that may be found. Refer to page 7C-13 of repair section for information.

2-Speed Circuit

If the 2-speed function will not shift when actuated, either the electrical circuit is faulty, the valve spool is stuck, or there is not adequate pressure.



1. Ensure there is adequate pilot pressure. Refer to page 7B-21. If pressure is OK, continue.

NOTE: The manual override should only be used when troubleshooting the park brake circuit.

2. Activate manual override button **(1)** by pressing down and turning counterclockwise.

   Expected result: The valve spool should shift. If so, the problem is electrical. Continue testing the electrical circuit. See below. If spool will not shift, test hydraulic circuit. See following page. If spool does shift, but motor does not change speed, the problem is most likely internal to the motor. Replace motor. Refer to page 7C-11 for information.

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Electrical Troubleshooting

The 2-speed electrical control is part of the steering control circuits. The electrical procedures are used to test for opens, shorts or high resistance in the park brake circuit. Refer to page **7B-10** for circuit diagrams and test procedures.

Hydraulic Troubleshooting

NOTE: Contaminants in hydraulic oil, over a period of time, can build up between moving parts and housings and cause the valve spool to stick. Leaking O-ring seals and backup washers can also affect the output flow of the valve.

1. Remove, inspect, and clean cartridge valve components DC1. Replace any faulty seals or O-rings that may be found. Refer to page **7C-13** of repair section for information.
2. If 2-speed still does not function, the problem is most likely internal to the motor. Replace motor. Refer to page **7C-11** of repair section for information.

Chapter 7: Ground Drive Subsystem

Section C: Repair

INTRODUCTION

This section consists of repair procedures including the removal, replacement, installation, repair, and adjustments of those hydraulic and mechanical components responsible for operation of the ground drive.

Components

Hydraulic:

- Pumps PMP4 & PMP5
- Motors B6 & B7
- Park Brake/2-Speed Valve A2

Mechanical:

- Planetary/Gearbox Sprocket
- Tracks, Rollers
- Idler Wheel & Tensioning Cartridge

HYDRAULIC REPAIR

General Guidelines When Servicing the Hydrostatic Drives

The hydrostatic drive components are precision-built to very close tolerances and operate at very high pressures. Cleanliness is extremely important, when servicing a hydrostatic system. Use care to avoid allowing dirt, dust or debris to enter the hydraulic system. Contaminated oil will ruin the pump and motor in a short amount of time.



WARNING: Pressurized fluid can penetrate body tissue and result in serious injury or death. Leaks can be invisible. Keep away from any suspected leak. Relieve pressure in the hydraulic system before searching for leaks, disconnecting hoses, or performing any other work on the system. If you must pressurize the system to find a suspected leak, use an object such as a piece of wood or cardboard rather than your hands. When loosening a fitting where some residual pressure may exist, slowly loosen the fitting until oil begins to leak. Wait for leaking to stop before disconnecting the fitting. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

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Avoid Oil Contamination

Warranty claims may be denied if damage is caused by contaminated hydraulic fluid.

Before Repairing (Opening the System):

1. Clean dirt from hose connections and around pump and motor ports before loosening any connection.
2. Use new, clean plugs to plug disconnected hoses. If clean plugs are not available, place plastic bags (such as sandwich bags) over the ends of hoses and hold them in place with rubber bands. Also use new clean caps to cap off fittings.

The hydrostatic system can be easily damaged by contamination or lack of oil during start up. After repairing a hydrostatic system, use the following procedure to assure there is an adequate supply of filtered oil to each part of the system:

After Repairing (Returning the System to Service):

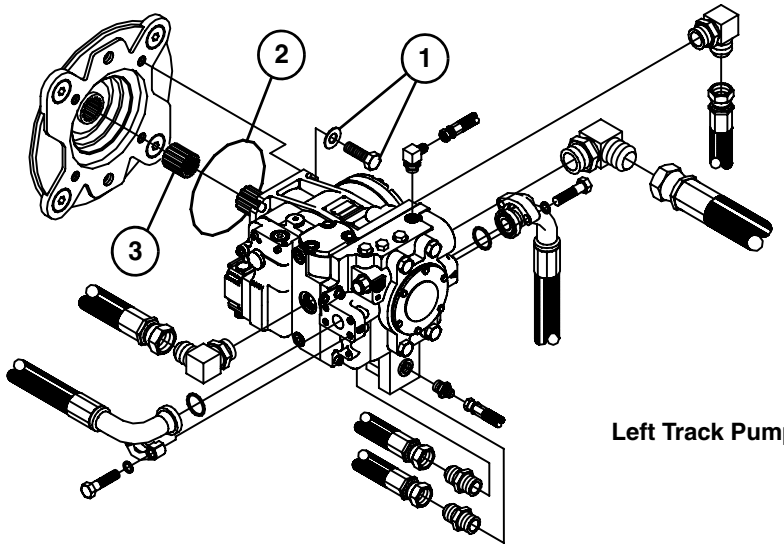
1. All oil supply components (tank, hoses, tubes, fittings) must be clean. If possible, use a foam projectile cleaning system. Otherwise, rinse all components with clean solvent (solvent must be filtered through a 10-micron filter), and dried with filtered air before installation.
2. Fill oil tank with the recommended hydraulic oil. If replacing a pump or motor, fill case with oil before starting the machine. Filter oil with a 10-micron oil filter as it is added to the tank, pump, or motor. Do not reuse old hydraulic oil.
3. Whenever a hydrostatic system has been opened, crank engine without allowing it to start until charge pressure is 25–50 psi (17–34 bar). This can be accomplished by removing power wire from the engines run relay. This will keep the engine from starting.
4. Turn ignition switch to START to crank the engine. When charge pressure of 25–50 psi (17–34 bar) is established, return ignition switch to OFF and reconnect fuel solenoid power wire.
5. Start engine.

NOTE: The machine must be on suitable jack stands with the tracks off the ground or the tracks will need to be removed before operating the circuit.

6. Run the affected system FORWARD for at least 15 minutes.
7. Do not run a new motor over half speed until the motor has been worked under full load.
8. Take an oil sample from the closed loop whenever replacing components or before setting high pressure relief valves. Refer to “Hydraulic Oil Sampling,” page **4B-5** of the Fluid Conditioning Troubleshooting section for oil sampling criteria.
9. Refer to *“Calibration,” page* **2-25** in System Information Chapter.

Track Drive Pumps PMP4 & PMP5

The pumps can be replaced as a complete unit or partially serviced. The multifunction valves, control EDC, charge pressure relief valve, and shaft seals are serviceable.



Left Track Pump Shown

Remove

To remove a pump:

1. Follow *"Shutdown Procedure," page* **2-1**.
2. Before working on the hydraulic system, release pressure in the oil tank by loosening filler cap.
3. Refer to page **7C-1** and read general guidelines when servicing.

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4. Remove cross conveyor assembly. Refer to the cross conveyor repair section page 9C-9 for removal instructions.
5. Label and disconnect each hose from pump. Plug all hoses and ports; cap all fittings.
6. Unplug wire harness connector from EDC.

NOTE: To remove a track drive pump, you may also have to remove the attachment pump above it.

7. Drain oil from the pump drive gearbox.
8. Remove four bolts and washers **(1)**.
9. Using a suitable lifting device, pull pump straight off pump drive gearbox.
10. Remove O-ring **(2)** from pump. If damaged, replace before installing new pump.
11. Retain adapter sleeve **(3)** for reuse.

Install

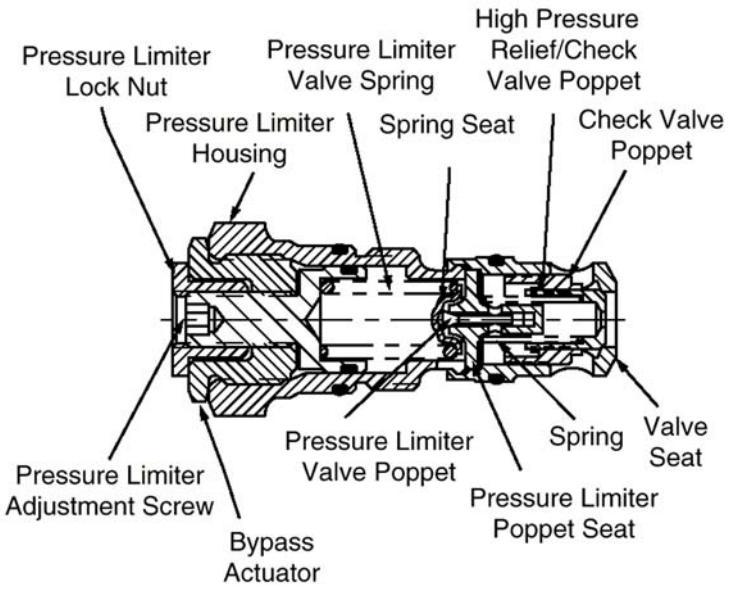
Reverse removal procedure to install new pump. Be sure to install O-ring and adapter between pump and gearbox.

- Add oil to the pump drive gearbox. Fill between add and full marks on dipstick. Refer to *"Fluid and Lubricants," page* **2-7** for oil requirements.
- Apply Molykote G-N paste to spline of pump shaft, adapter and pump drive.
- Torque bolts **(2)** according to standard torque charts.
- Read and follow "Returning the System to Service" information on page 7C-2 before starting engine.

Pump Multifunction Valves

NOTE: If the track drive circuit will only work in one direction, try switching the multifunction valves. If the problem is now in the opposite direction, the multifunction valve is faulty.

The multifunction valves can be replaced as a complete unit or disassembled and repaired with new seals.



Remove

1. Remove multifunction valve cartridge with a 1-1/4″ wrench on the largest hex of the cartridge.



2. Inspect cartridge for damage to internal parts and O-rings. The multifunction valve cartridge may be disassembled for cleaning. However, if the pressure limiter housing assembly is disassembled, the pressure settings must be readjusted. See following page for information on adjusting pressures.

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Usually, if there is contamination problem, it will be in the valve seat assembly. If it is not necessary to clean the interior of cartridge, proceed to Step 7.

Multifunction valve components (except O-rings) are not sold separately as service parts. If damaged, replace complete valve assembly.



3. The valve seat section is pressed over a lip. Place cartridge in a vise and pry lower section off with an appropriate tool. Maintain sufficient control to prevent contents from flying loose.
4. Remove pressure limiter lock nut and bypass actuator.
5. Unscrew pressure limiter adjustment screw from bypass actuator.
6. Clean and inspect all disassembled parts.

IMPORTANT: Assemble with new, lightly lubricated O-rings by reversing above procedure. Place cartridge in a vise and press on lower assembly. **The pressure settings must be readjusted after disassembling the pressure limiter housing of the multifunction valve cartridge.** Refer to Troubleshooting, Section B, for information on adjusting the pressures.

Install

7. Install cartridge in multifunction valve cavity and torque to 66 ft-lb (89 Nm). Do not overtorque multifunction valve cartridge.

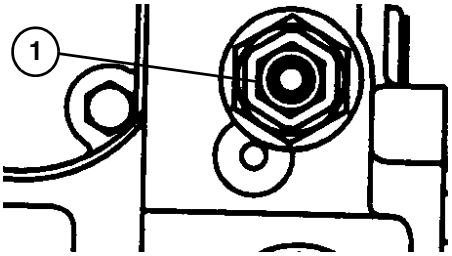


High Pressure Limiter - Adjust

NOTE: The following procedure refers to setting the high pressure in the FORWARD drive multifunction valves. Repeat procedure for setting the REVERSE drive multifunction valves.

WARNING: Machine could move unexpectedly if the park brake fails to hold during test. Clear area of all unnecessary persons. Death or serious injury is possible if run over or crushed.

1. Loosen lock nut **(1)**. This is the smallest hex on multifunction valve.
2. Insert internal hex wrench into pressure-adjusting screw.



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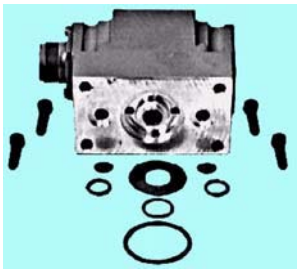
3. Push propel handle to FORWARD and adjust pressure limiter setting by rotating pressure adjusting screw with internal hex wrench. Turning clockwise will increase pressure setting, counterclockwise will decrease pressure setting. Each complete rotation of adjusting screw changes pressure approximately 1350 psi (93 bar).
4. Adjust until pressure reaches 5000 psi (345 bar).
5. Adjust pump to return to its NEUTRAL position. The pressure in the high pressure circuit should return to charge pressure setting.
6. Hold pressure adjusting screw stationary, and tighten pressure adjusting lock nut 26 in-lb (16 Nm).
7. Follow *"Shutdown Procedure," page* **2-1**.

Pump EDC (Electric Displacement Control)

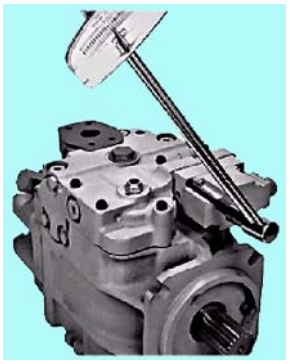
The **EDC** unit can be replaced as a complete unit or disassembled and repaired.

PCP (Pressure Control Pilot) - Remove

1. Thoroughly clean external surfaces of control.
2. Using a 4 mm Allen wrench, remove four screws and remove PCP.
3. Check surfaces for nicks or damage. Clean internal screens.
4. Install new O-rings in PCP Housing. Place PCP against EDC housing and install the screws. Torque to 48 in-lb (5.4 Nm).



Do not remove black plastic cover from the aluminum plate. This is not a serviceable item and will void the product warranty.

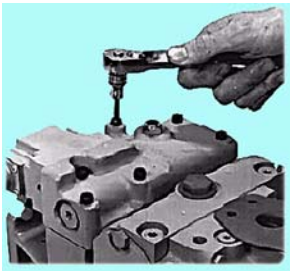


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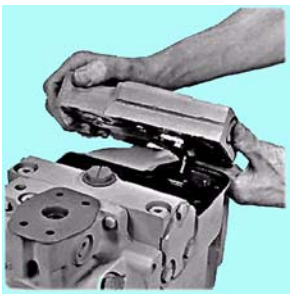
EDC - Remove

1. Thoroughly clean external surfaces prior to removal of control. Using a 5 mm Allen wrench, remove eight control-mounting screws.



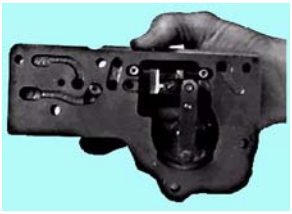
Protect exposed surfaces and cavities from damage and foreign material.

2. Remove control (with orifice check valve and spring) and control gasket from housing.



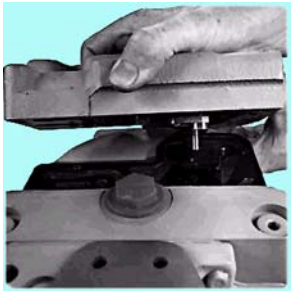
Install

1. In preparation for installing the control, place a new gasket on housing. Inspect to ensure control orifice check valve and spring are in their proper position in control.



WARNING: Failure to properly engage the feedback link can cause pumps not to be nulled. The machine could move with the track drive controls in NEUTRAL when the engine is started. Serious injury or death can result if struck or run over by machine or entangled in the rotating attachment.

2. While setting the control into position, engage pin on the control linkage into the mating hole in link attached to the swashplate.



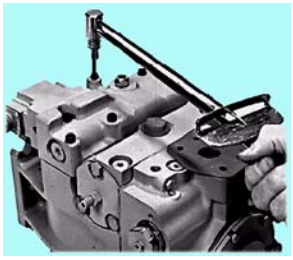
With the control in position, move control assembly left and right to check engagement of pin in link. Proper engagement will be indicated by an increasing resistance as the control is moved away from center position.
Non-engagement of pin will be indicated by lack of spring force. In case of non-engagement, remove control and repeat above procedure.

Continued on next page...

3. Align control gasket and install screws.
4. Torque screws to 12 ft-lb (16 Nm).



A sealing washer must be installed under the head of any mounting screws that are installed into (through) holes in the housing.



EDC Neutral Setting - Adjust

NOTE: The neutral adjustment is the only adjustment that can be made on the electric displacement control. All other functions are factory preset. The adjustment must be made on a test stand or with pump(s) on the machine.

WARNING: If adjustment is made with pump(s) installed on machine, the following procedure requires the machine to be raised to get the tracks off the ground. The tracks will move during adjustment.

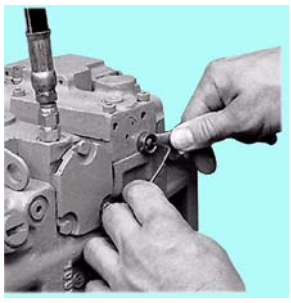
Use matched calibrated gauges when adjusting EDC neutral.

1. Install a 1000 psi (70 bar) gauge in each of the two displacement control cylinder gauge ports (M4 and M5). Disconnect EDC. Start engine and operate at full throttle



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2. Loosen lock nut with a 13 mm wrench. Using a 4 mm Allen wrench, rotate clockwise until pressure increases in one of the pressure gauges. Note the angular position of wrench. Then rotate neutral adjusting screw counterclockwise until pressure increases by an equal amount on the other gauge. Again, note angular position of wrench.
3. Rotate adjusting screw clockwise half the distance between the locations noted above. The gauges should read the same pressure (case pressure), indicating that the control is in its NEUTRAL position.
4. Hold the neutral adjusting screw stationary. Tighten neutral adjusting screw lock nut to 120 in-lb (13.6 Nm). Do not overtorque nut.
5. Once the NEUTRAL position is set, stop engine, remove gauges, and install gauge port plugs. Connect external control input.

Track Drive Motors B6 & B7

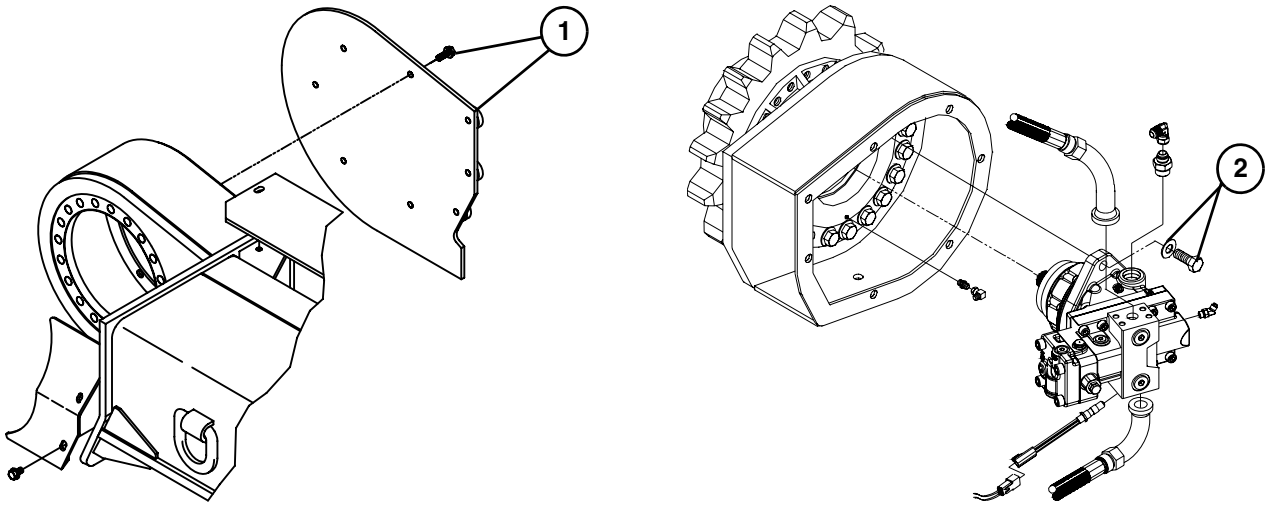
Track drive motors can be replaced as a complete unit or partially serviced. Only the magnetic pickups and shaft seals are serviceable. Refer to "Track Motor PPUs," page **7B-13** for information on magnetic pickup replacement.

Remove

To remove a motor:

IMPORTANT: Before working on the hydraulic system, release pressure in the oil tank by loosening filler cap.

Right Track Motor Shown



1. Follow *"Shutdown Procedure," page* **2-1**.
2. Refer to page **7C-2** and read general guidelines when servicing.
3. Remove cover plate and mounting bolts **(1)** covering drive motor.
4. Label and disconnect each hose from motor. Plug all hoses and ports; cap all fittings.
5. Unplug wire harness connector from magnetic pickup.
6. Remove two bolts and washers **(2)**.
7. Using a suitable lifting device, pull motor straight out of the track frame assembly.

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Install

Reverse removal procedure to install new motor.

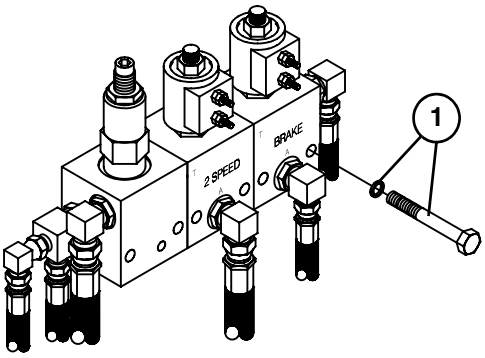
- Torque bolts **(1)** according to standard torque charts.
- Read and follow instructions in page **7C-2** before starting engine.

Park Brake/2-Speed Valve A2

Remove

To remove complete valve assembly:

1. Follow *"Shutdown Procedure," page* **2-1**.
2. Loosen cap on oil tank to relieve pressure from tank.
3. Label and disconnect each hose from valve assembly. Plug all hoses and ports; cap all fittings.
4. Disconnect wires from solenoid coils.



5. Remove valve mounting bolts and lock washers **(1)**. Remove valve assembly.

Install

- Reverse removal procedure.
- Torque bolts **(1)** according to standard torque charts.

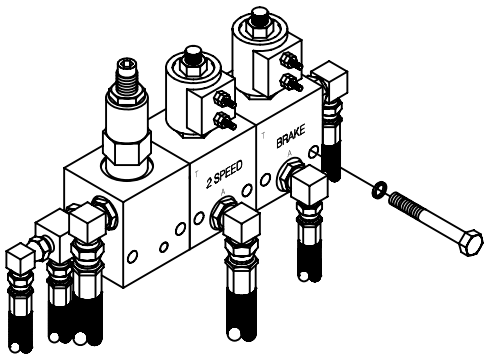
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Cartridge Valves

The cartridge valves can be replaced as a complete unit or repaired with a seal kit. If troubleshooting determines the coil is bad, replace the complete unit.

Remove

To remove a cartridge valve:



1. Follow *"Shutdown Procedure," page* **2-1**.
2. Loosen cap on oil tank to relieve pressure from tank.
3. Unplug wire connections from solenoid coil.
4. Loosen valves at bottom hex and turn valve counterclockwise. Remove valve.

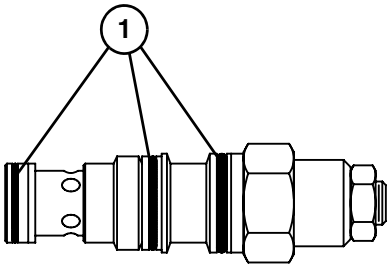
Install

1. Inspect new cartridge to ensure no external contaminant is present.
2. Inspect manifold cavity for burrs or other irregularities which could damage O-rings during installation.
3. Dip new cartridge in clean, filtered oil.
4. Screw cartridge in by hand until top O-ring is met, then wrench-tighten.
5. Tighten tank fill cap.

Seals - Replace

To replace seals:

1. Remove cartridge to be repaired from valve assembly. See instructions above.



NOTE: The illustration is a generic representation of a cartridge valve. The valve seal replacement procedure is the same for all of the cartridge valves.

2. Remove old seals **(1)**. Note orientation of the backup washers and O-rings. This will ensure new seals will be installed correctly.
3. Install new seals in order old ones were removed.
4. Install valve using instructions given above.

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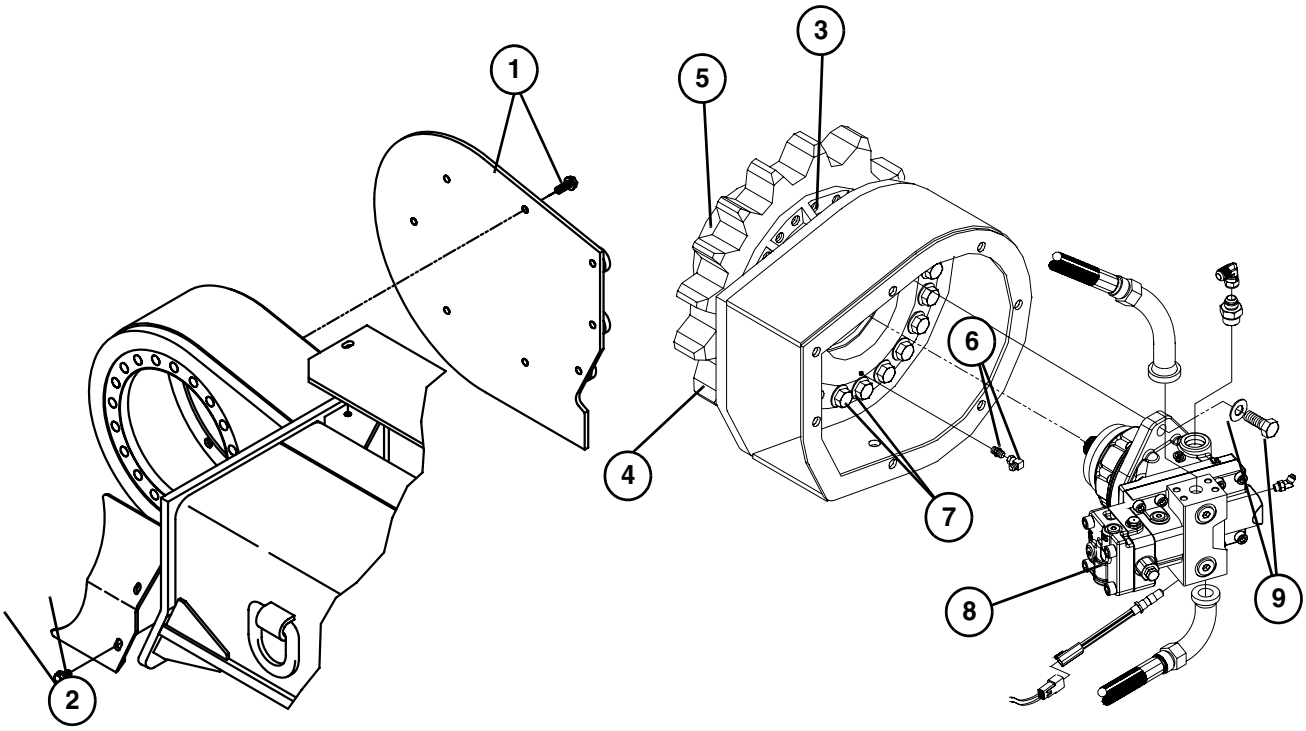
MECHANICAL REPAIR

Planetary Gearbox/Sprocket

To gain access to remove or replace gearbox and sprocket, the track chain must be removed. Refer to page 7C-18.

NOTE: If a new planetary has been installed, allow it to run-in at moderate pressures and reduced speeds. After a short period of operation, check oil level. Change oil in planetary after the first 100 hours of operation. Refer to the T655III *Maintenance Manual* for information on checking and changing the oil.

Remove



1. Remove bolts and planetary shield **(1)** to expose the drive motor **(8)**.
2. Remove bolts and washers **(9)** from motor-mounting flange. Do not remove any motor hoses.
3. Pull motor **(8)** from gearbox **(5)**.
4. Remove and cap brake line hose and fitting **(6)** from gearbox.
5. Remove sprocket shield and mounting bolts **(2)**.

Continued on next page...

6. Remove bolts and washers **(3)** from sprocket side of gearbox. Lift sprocket **(4)** up and out from gearbox.
7. Remove bolts and washers **(7)** from track frame. Lift gearbox from the frame.

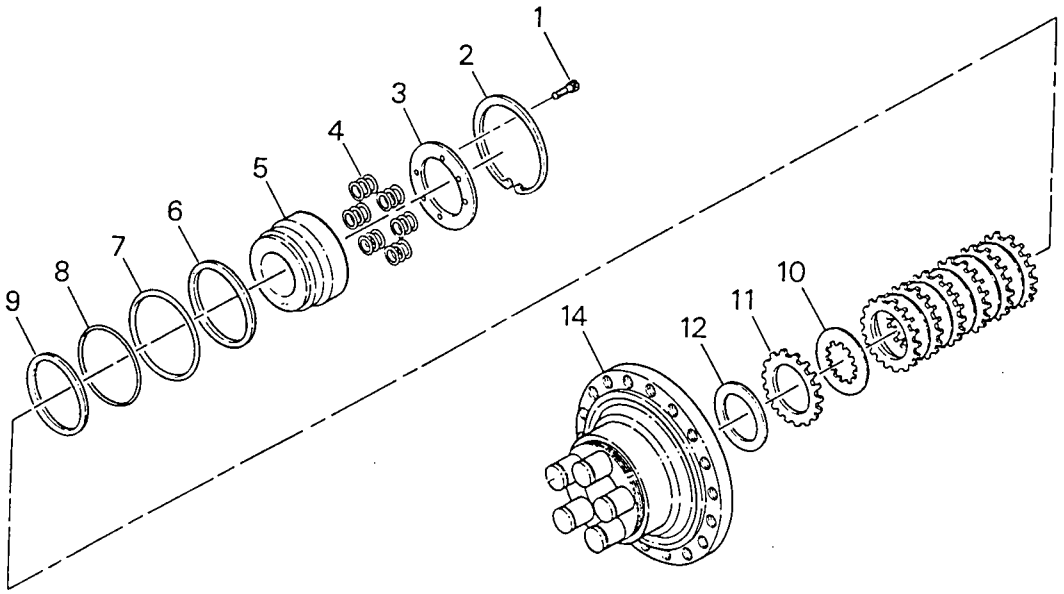
Install

Reverse removal procedure to install.

- Apply a light film of Molykote paste to motor splines.
- Apply sealant to threads of bolts **(3)**. Torque to 800 ft-lb (1085 Nm).
- Torque bolts **(7)** to 800 ft-lb (1085 Nm).
- Torque bolts **(9)** to 340 ft-lb (460 Nm).
- Torque bolts **(1)** to 60 ft-lb (80 Nm).

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Planetary Brakes



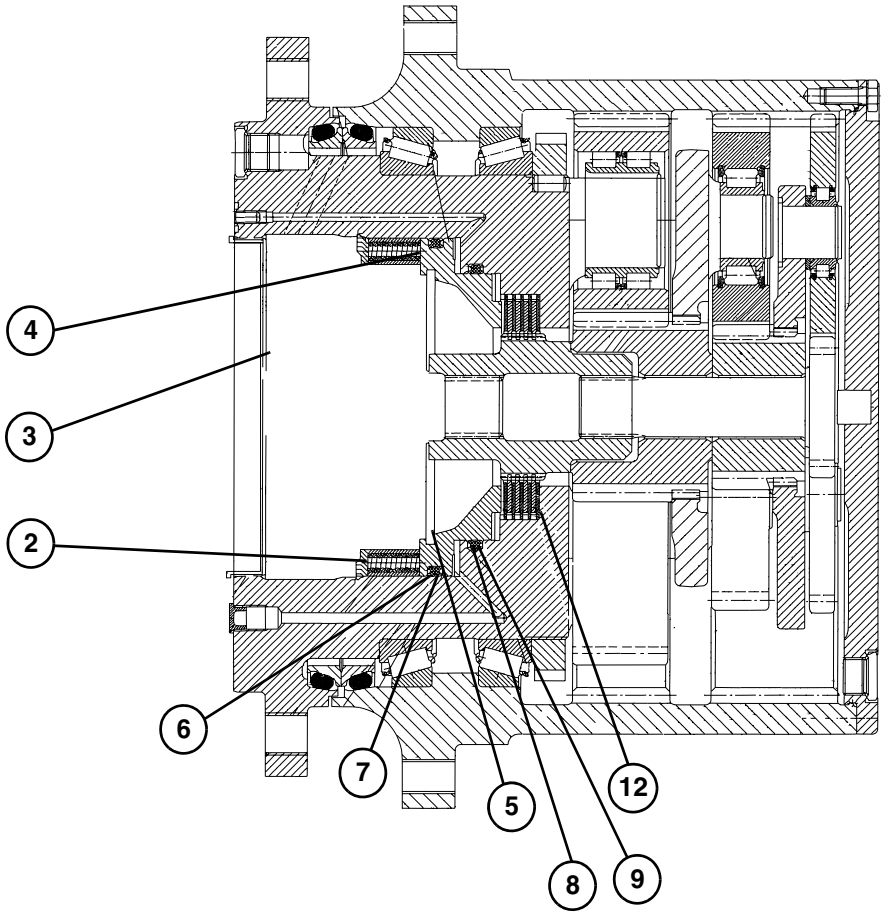
Replace

1. Remove track drive motor. Refer to page 7C-11.
2. Obtain cap screws **(1)** to fit into position. Screw in evenly to remove spring tension on snap ring **(2)**.
3. Remove snap ring and remove bolts in an alternating pattern. Remove thrust plate **(3)**, springs **(4)**, piston **(5)**, anti-extrusion ring **(6)**, O-rings **(7)** and **(8)**, and anti-extrusion ring **(9)**.
4. Inspect piston and end plate for damage; replace if necessary.
5. Install new plates and disks in the same order that they were removed.

NOTE: Refer to the following page for orientation of O-rings and anti-extrusion rings.

Continued on next page...

6. Install a new anti-extrusion ring **(9)**.
7. Install a new O-ring **(8)**.
8. Install a new O-ring **(7)**.
9. Install a new anti-extrusion ring **(6)**.
10. Lightly grease walls of brake housing to protect O-rings.
11. Install piston **(5)**.
12. Install springs **(4)** into piston.
13. Position thrust plate **(3)** on the piston **(5)**, aligning the screw holes.
14. Start screws **(1)** and tighten down evenly.
15. Install retaining ring **(2)**. Remove cap screws.
16. Pressure test brake before installing motor.

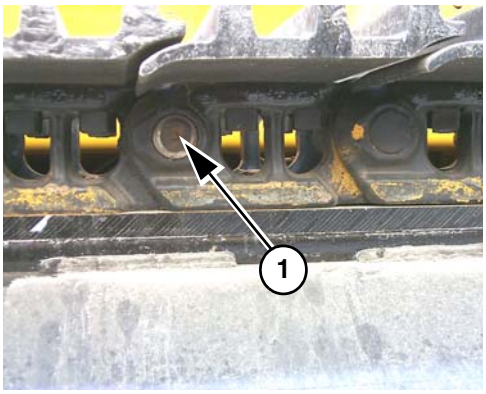


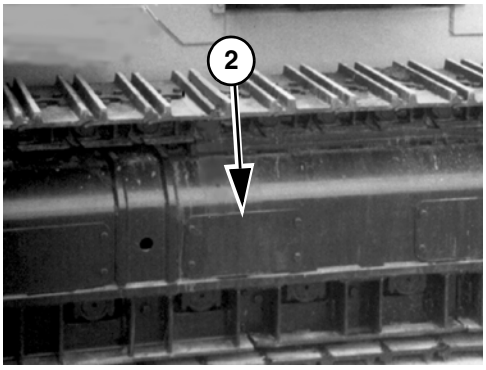
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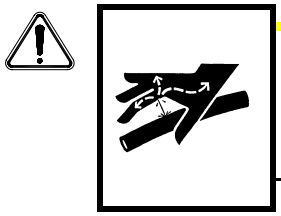
Tracks

Remove

1. Use a jack to lift side of machine being worked on at least 6″ (15.2 cm). The track assembly must clear the surface. Use suitable blocking under machine frame at the front and rear for support.
2. Look at the ends of the pins in the links. Locate master pin. The master pin **(1)** has a recessed hole machined into the end of it.
3. Start engine and use track motor control to slowly rotate track until the link with the master pin is on top.
4. Follow *"Shutdown Procedure," page* **2-1** .
5. Remove access cover **(2)**.

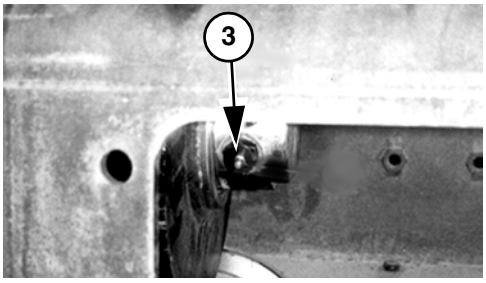






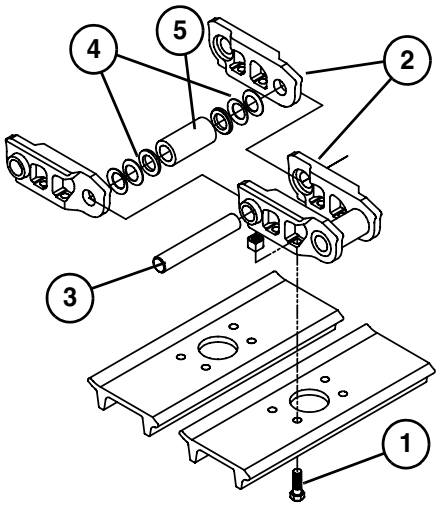
WARNING: Pressurized grease behind grease fitting can penetrate body tissue and result in serious injury or death. Never loosen grease fitting before releasing pressure by loosening check valve. Grease injected under skin must be removed immediately by a surgeon familiar with this type of injury.

6. Slowly turn fill/check valve **(3)** of the grease cylinder counterclockwise to release the tension. Grease will begin leaking around the valve. All tension on the track is gone when grease stops flowing out of valve. Clean grease from cartridge area.



Continued on next page...

7. Remove four bolts **(1)** from each track pad directly over the master link **(2)**. There are two pads over the master link.
8. Drive master link pin **(3)** through the track. Collect washers **(4)** and bushing **(5)** that fall when master pin is removed. These washers will be reused in assembly procedure.
9. Lift track from top side of track support frame; then pull it out from under the frame.



Install

1. Ensure track and pad direction are correct. If properly installed, the track rolls forward over the rear sprocket, each pad's forward edge goes under the trailing edge of the pad before it, as shown here.
2. Place chain assembly under track frame - pad side down. Loop one end of track over sprocket so 1.5 ft (0.5 m) extend beyond the sprocket. Ensure chain seats onto sprocket.



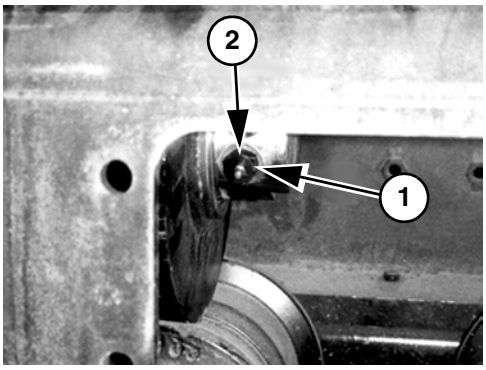
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3. Loop other end of track over idler wheel and pull it back toward sprocket end.

NOTE: The master pin may have the identifying hole in only one end. If so, remember to install it with the hole outward so it can be easily located in the future.

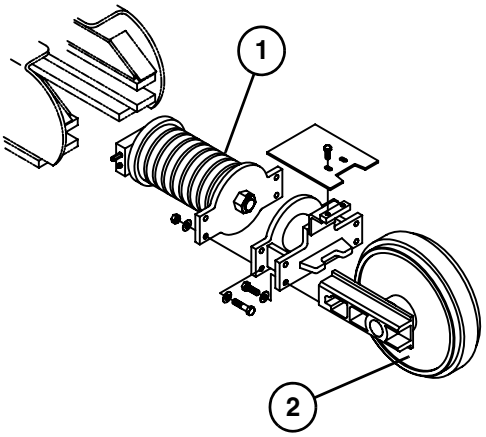
4. Apply a light film of grease to the master link pin. Align track ends. Install master bushing, seals, washers, and drive master pin into master link.
5. Install track pads over the master link. Remove blocking and lower the machine.
6. Tighten fill/check valve on the tension cartridge **(2)**.
7. Use a grease gun to pump grease into the track tensioning ball check **(1)**.
8. Refer to Tension Adjustment, page 7C-21 and adjust track tension.

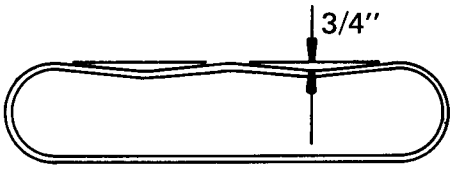


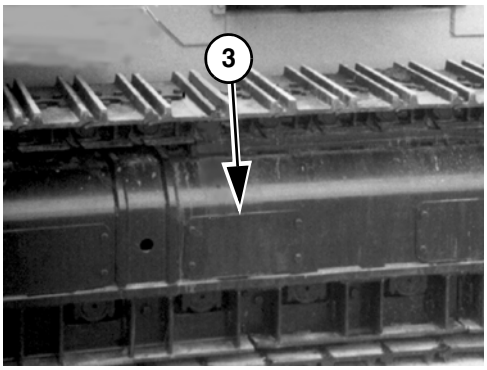
Track Tension

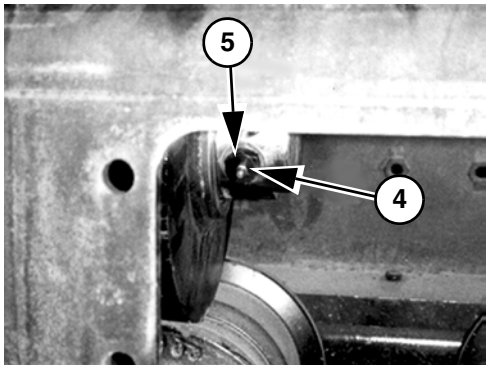
Adjust

1. Track tension is set with a tensioning cartridge **(1)** which compresses a spring against the idler roller **(2)**. There should be 3/4″ (2 cm) of slack, measured as shown. Tracks must be clean.
2. Remove access cover **(3)** from track frame.
3. To increase tension, add grease to the cylinder through ball check **(4)**.
4. To decrease tension, loosen cartridge **(5)** about one-half turn and release grease until track tension is correct. Tighten cartridge and remove grease from the track frame.
5. Install access cover **(3)**.









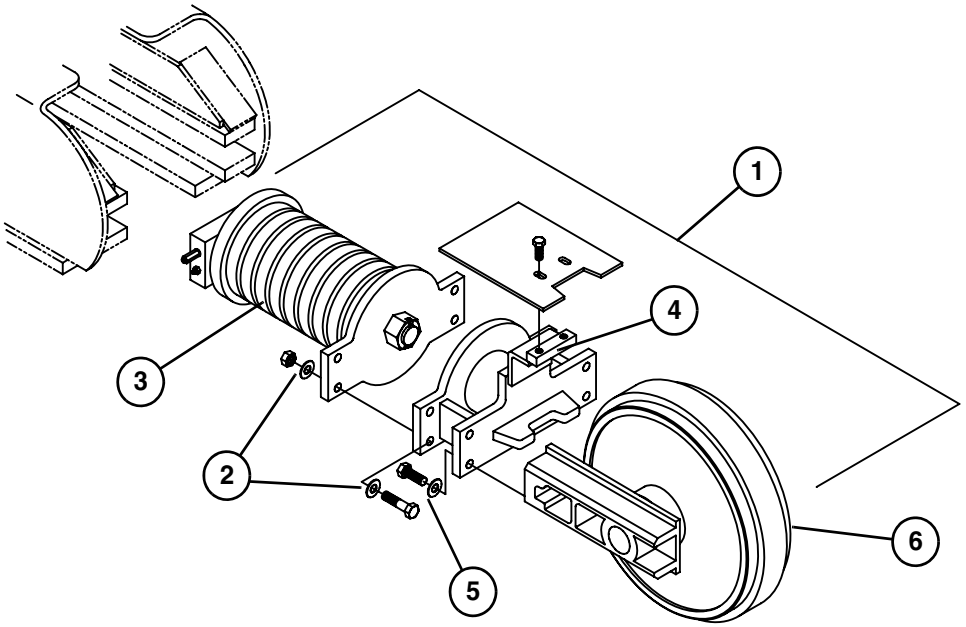
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Idler Wheel & Tensioning Cartridge

To gain access, or to remove or replace the idler wheel and track tensioner assembly, the track chain must be removed. Refer to page 7C-18.

NOTE: The track tensioner assembly must be replaced as a unit. Do not attempt to disassemble spring tensioner.

Remove



1. Pull complete assembly **(1)** from the track frame.
2. Remove bolts and washers **(5)** that attach the idler wheel slide rails to track tension yoke **(4)**.
3. Remove bolts, washers, and nuts **(2)** that attach the tensioner assembly to the track tension yoke **(4)**.

Install

Reverse removal procedure to install:

- Torque bolts to 144 ft-lb (195 Nm).
- Clean any dirt from end of the track frame.
- Slide complete assembly **(1)** into track frame.

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Rollers

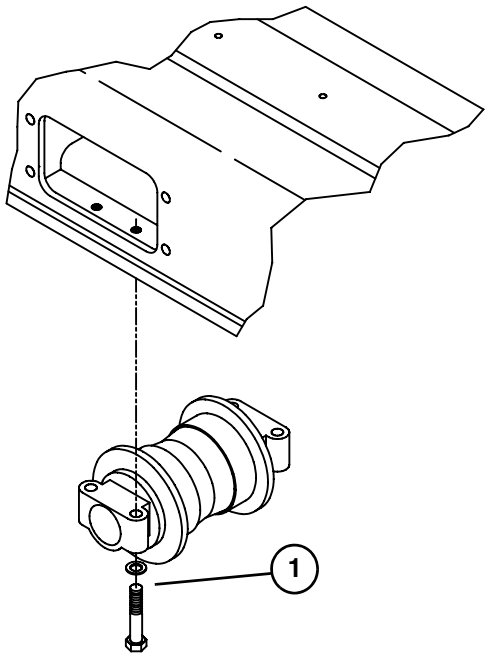
To gain access when removing or replacing track rollers, relieve track tension or remove chain. Refer to page 7C-18.

Remove

1. Remove one of the two bolts and washers **(1)** from each side of the roller.

NOTE: The roller is heavy enough that it may damage the threads if it is supported by only one bolt. To avoid this, support roller with suitable blocking when removing the last two bolts.

2. Back both of the remaining bolts out evenly to support the weight by both bolts. Remove blocking and roller when both bolts are free.



Install

Reverse removal procedure to install:

- Clean track frame roller mounting area of all dirt. All roller brackets must mount flush against frame and be free of preload.
- Push roller up against track frame and align its holes with holes in the frame. Wedge suitable blocking into place to hold roller.
- Apply sealant to bolt threads. Start a bolt with a washer into each hole. Tighten bolts evenly in a cross-bolt pattern and torque to 300 ft-lb (405 Nm).

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Chapter 8—Attachment Subsystem

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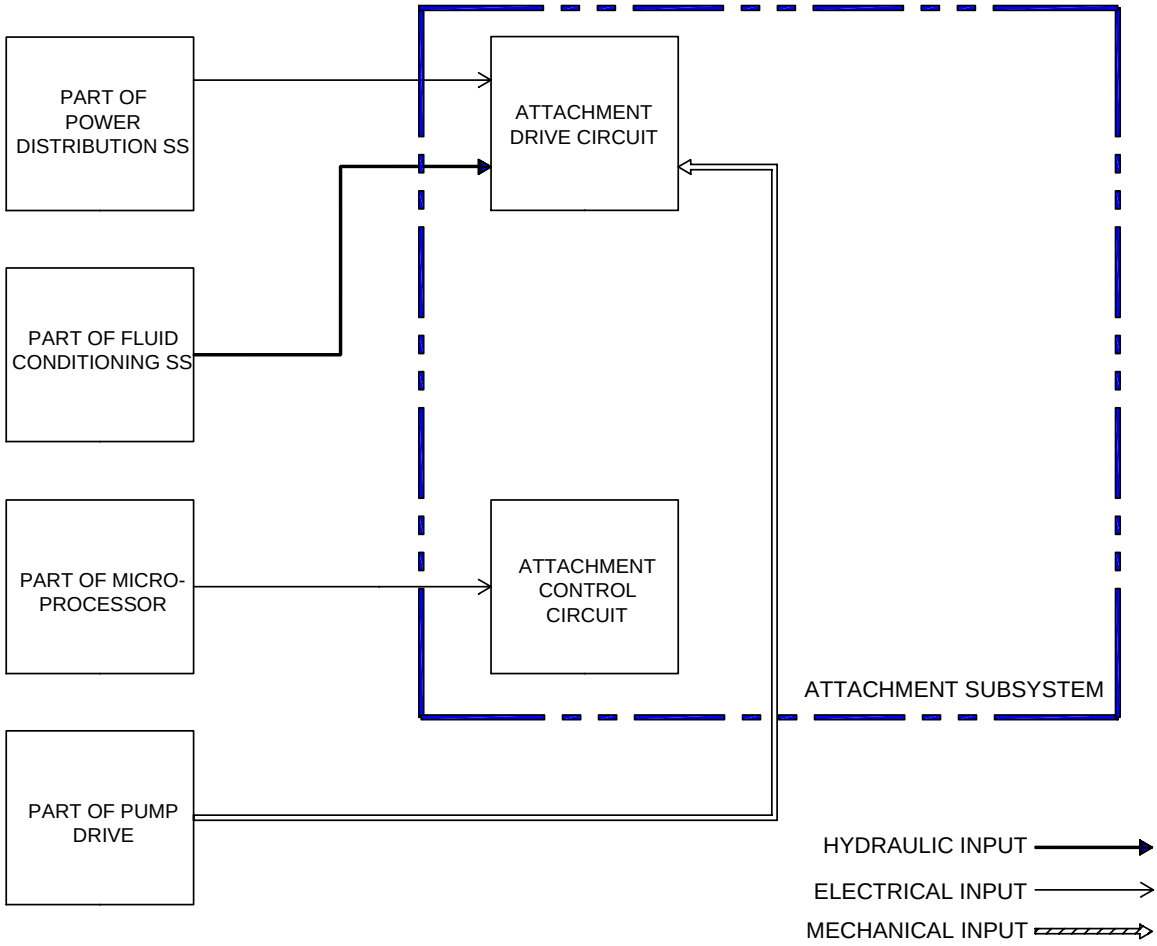
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Chapter 8: Attachment Subsystem

Section A: Theory

OVERVIEW

MAP



Lines and arrows on the MAP illustrate the interdependencies of the subsystems. The microprocessor, pump drive, power distribution, and fluid conditioning, subsystems, supply the electrical, hydraulic, and mechanical input necessary for operation.

The attachment subsystem consists of the circuits and components necessary for FORWARD and REVERSE drive operation of the trencher digging chain.

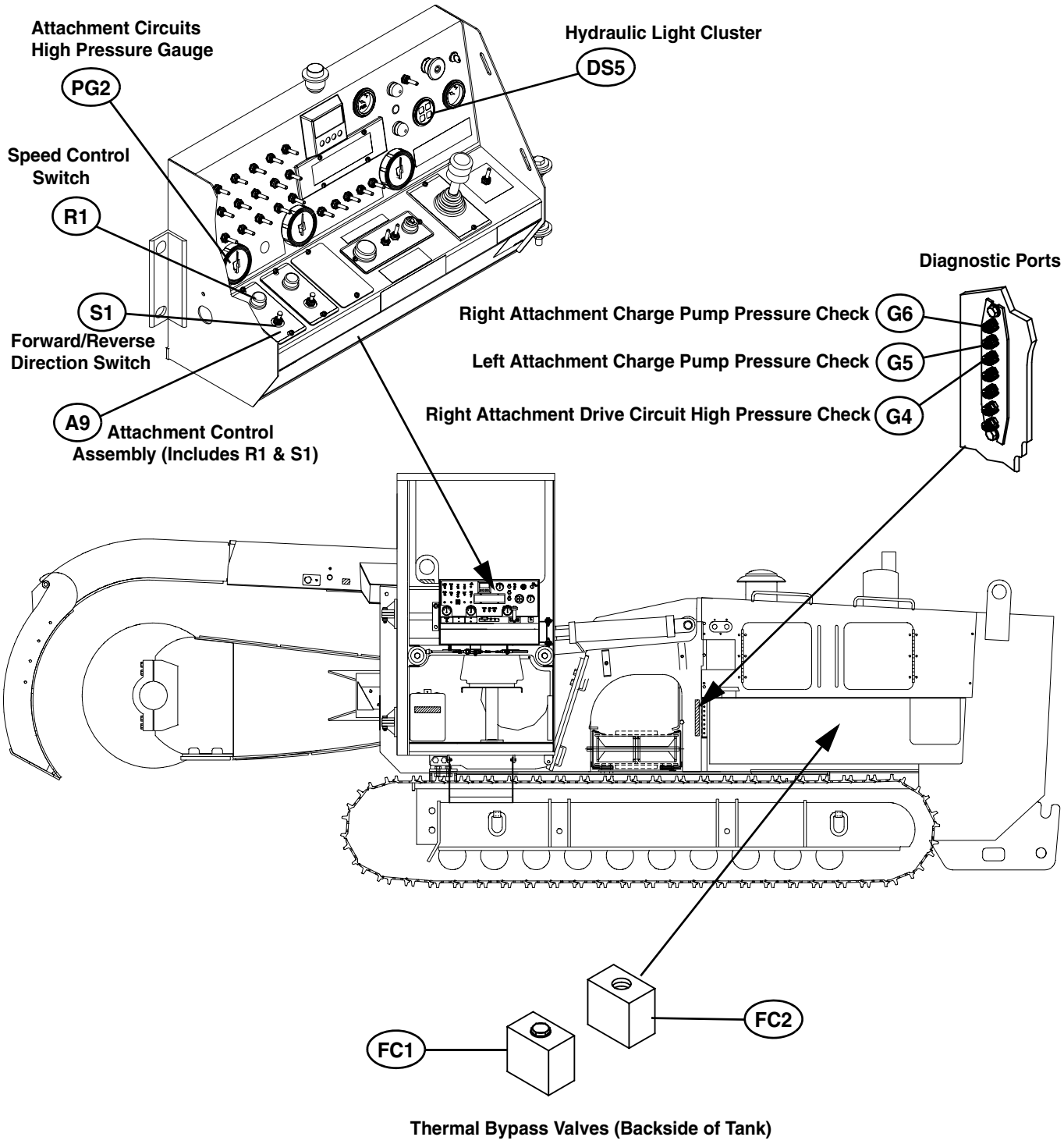
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Circuits/Components

Attachment Drive Circuit:

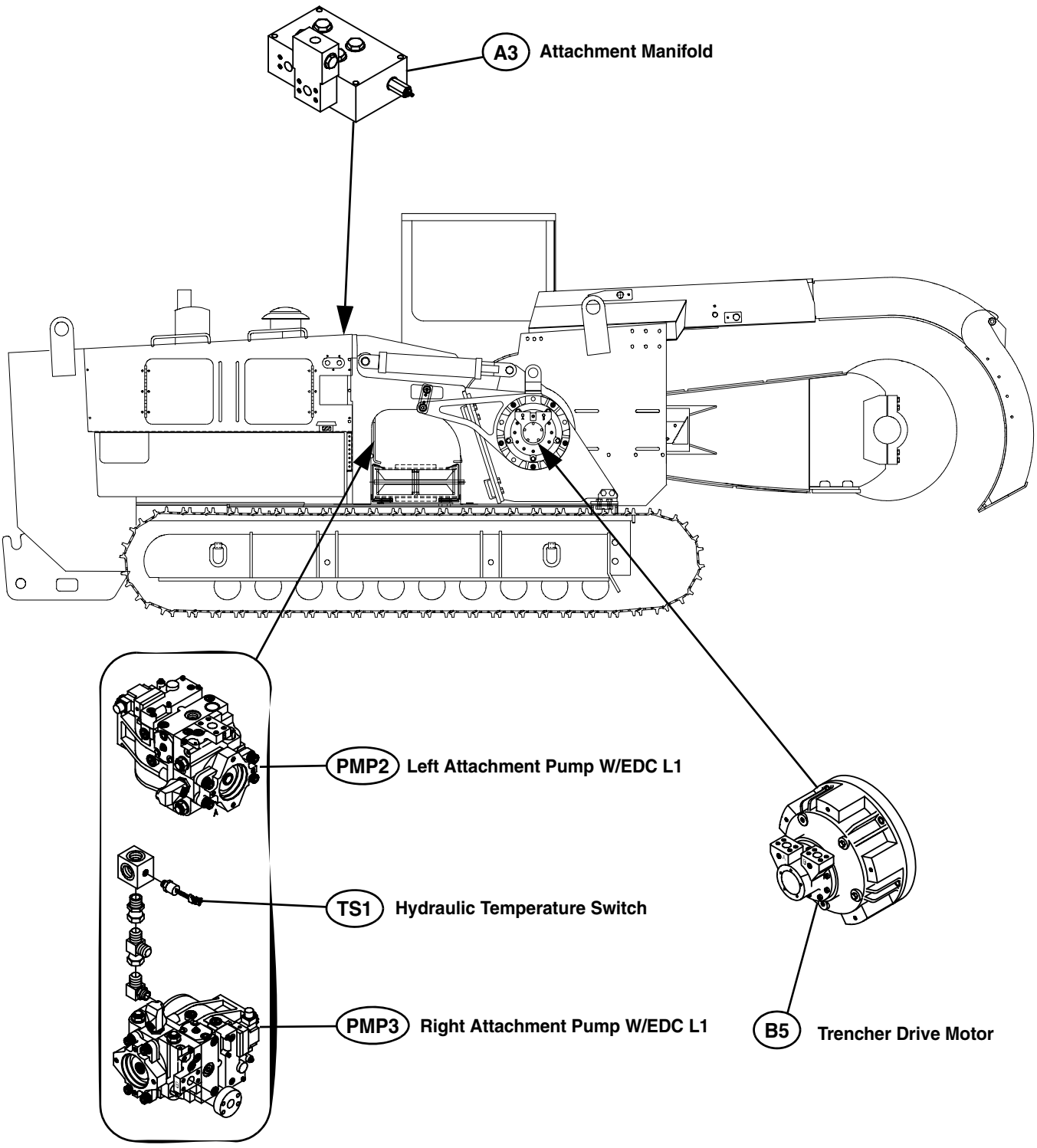
Fluid Conditioning Components
Microprocessor A5
Pump Drive Assembly
Hydraulic Motor B5
Attachment Circuits High Pressure Gauge PG2
Attachment High Pressure Diagnostic Port G4
Hydraulic Temperature Switch TS1
Left Attachment Hydraulic Pump PMP4
Left Attachment Charge Pump Filter FL6
Left Attachment Charge Pressure Diagnostic Port G5
Left Attachment Return Thermal Bypass Valve FC2
Right Attachment Hydraulic Pump PMP3
Right Attachment Charge Pump Filter FL7
Right Attachment Charge Pressure Diagnostic Port G6
Right Attachment Return Thermal Bypass Valve FC1

Component Locations



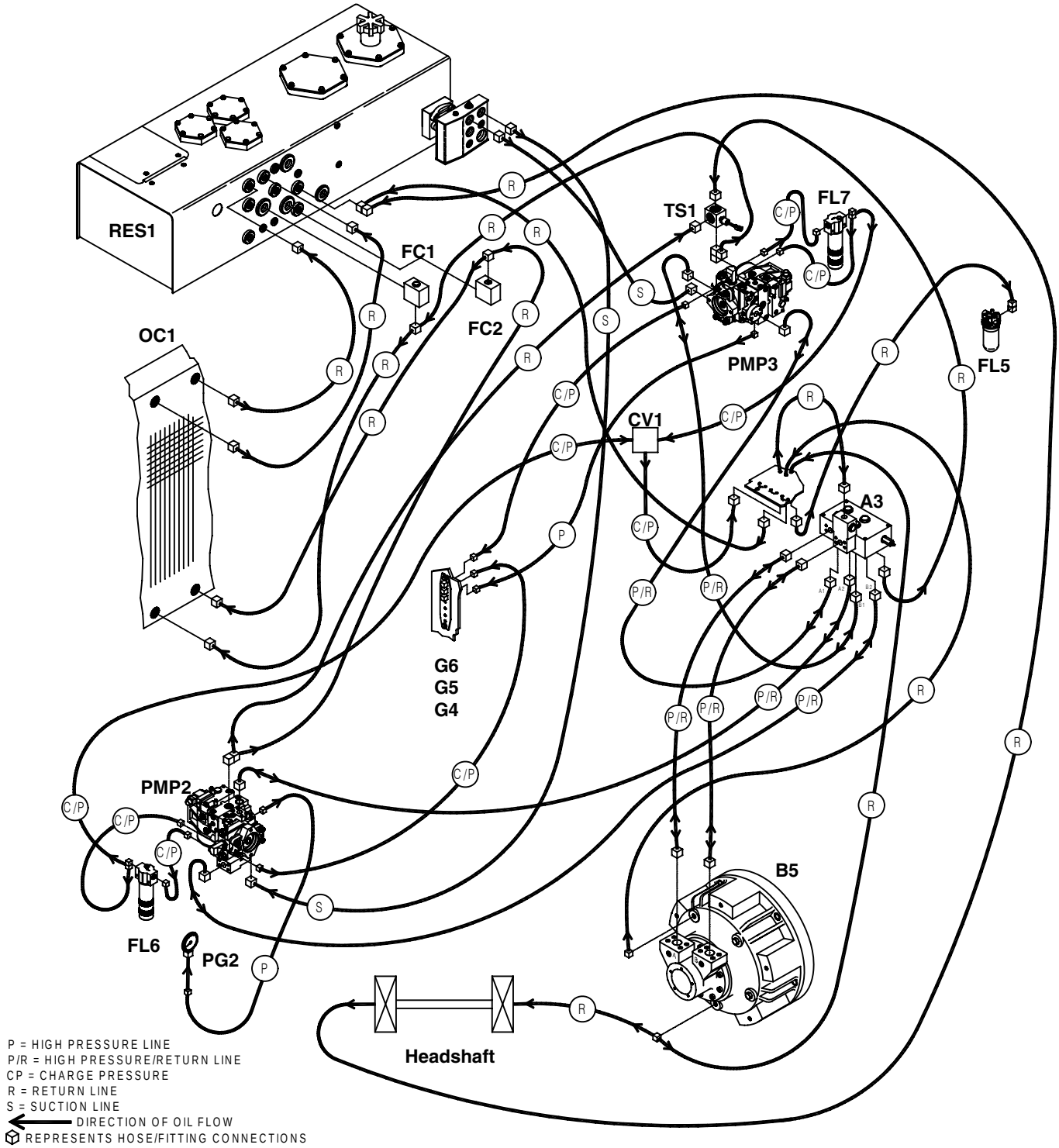
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Hydraulic Hose Connections

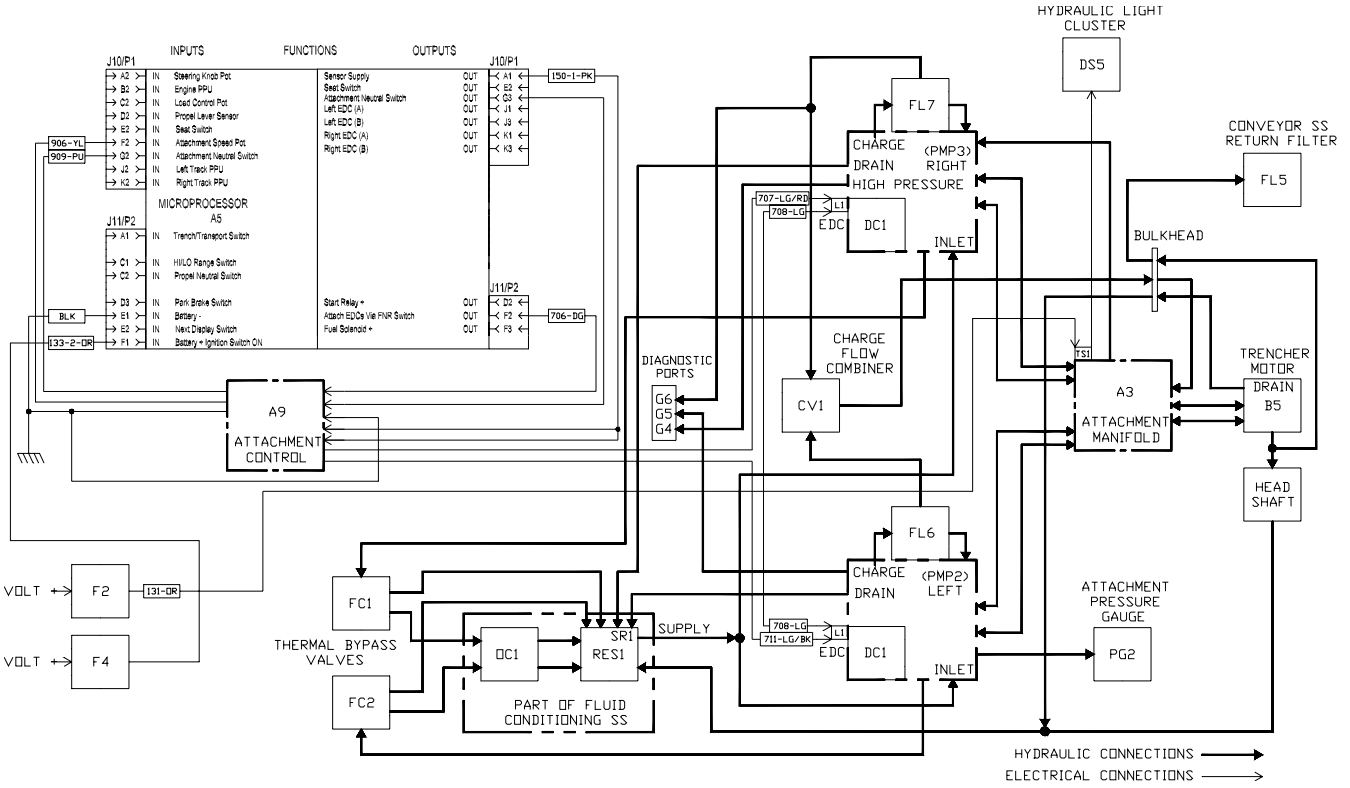
Note: Orientation of components does not reflect actual machine configuration.



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ATTACHMENT DRIVE CIRCUIT



Operation

The attachment drive circuit is electronically controlled and hydraulically actuated. The circuits are electronically controlled using the electronic attachment control module as well as the microprocessor (TEC 2000).

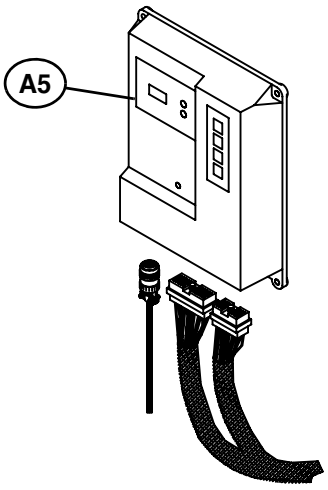
The hydraulic system used to drive the digging chain, is referred to as a closed-loop hydrostatic system. A common pump drive driven off the engine rotates the pumps. While the system is in operation, one side of the loop will be under high pressure (load generated pressure), while the opposite side of the loop is at charge pressure, plus case pressure. When the control is in NEUTRAL position (pump swashplate neutral), both sides of the closed loop are at charge pressure.

There are two main pumps driving the digger chain, the left attachment drive and right attachment drive pumps. The two pumps combine hydraulic flow to drive the trencher drive motor and digging chain.

Microprocessor A5

The microprocessor A5 is the main control for several circuits in multiple subsystems, therefore the following theory discusses the microprocessor and how it relates to just those electrical controls that are part of the attachment drive circuit.

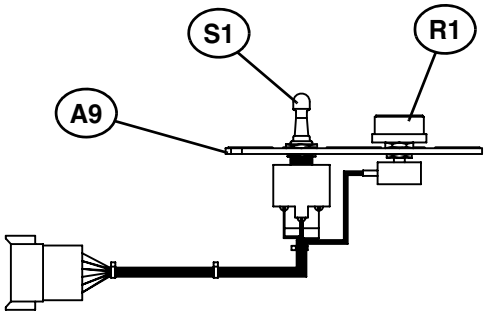
For basic operating information on the microprocessor, refer to Chapter 2 System Information.



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Attachment Control Circuit

The attachment control assembly A9 installed on the control panel incorporates two different control functions, including:



- directional control
- chain speed

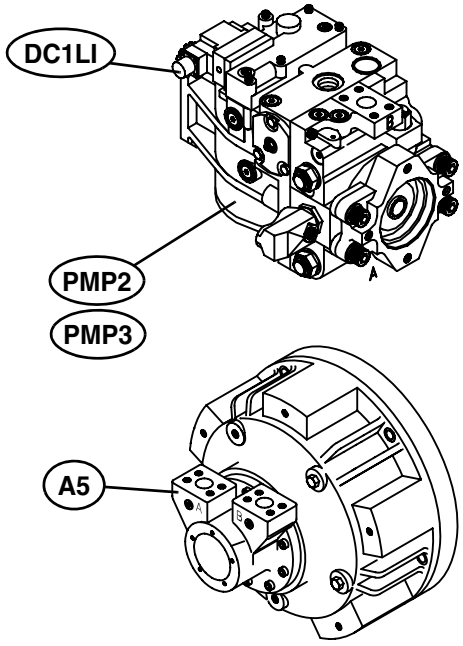
The attachment control consists of switch S1 and one potentiometer R1. Switch S1 controls FORWARD/ NEUTRAL/REVERSE and potentiometer R1 controls attachment drive speed.

The direction switch S1 and potentiometer R1 get voltage and ground from the microprocessor.

NOTE: The attachment control A9 is part of the machine's START interlock function. If the engine is shut down and the direction switch is not in the NEUTRAL position, the engine will not start. Refer to Engine subsystem Theory Chapter 5A for more information on the START interlock functions.

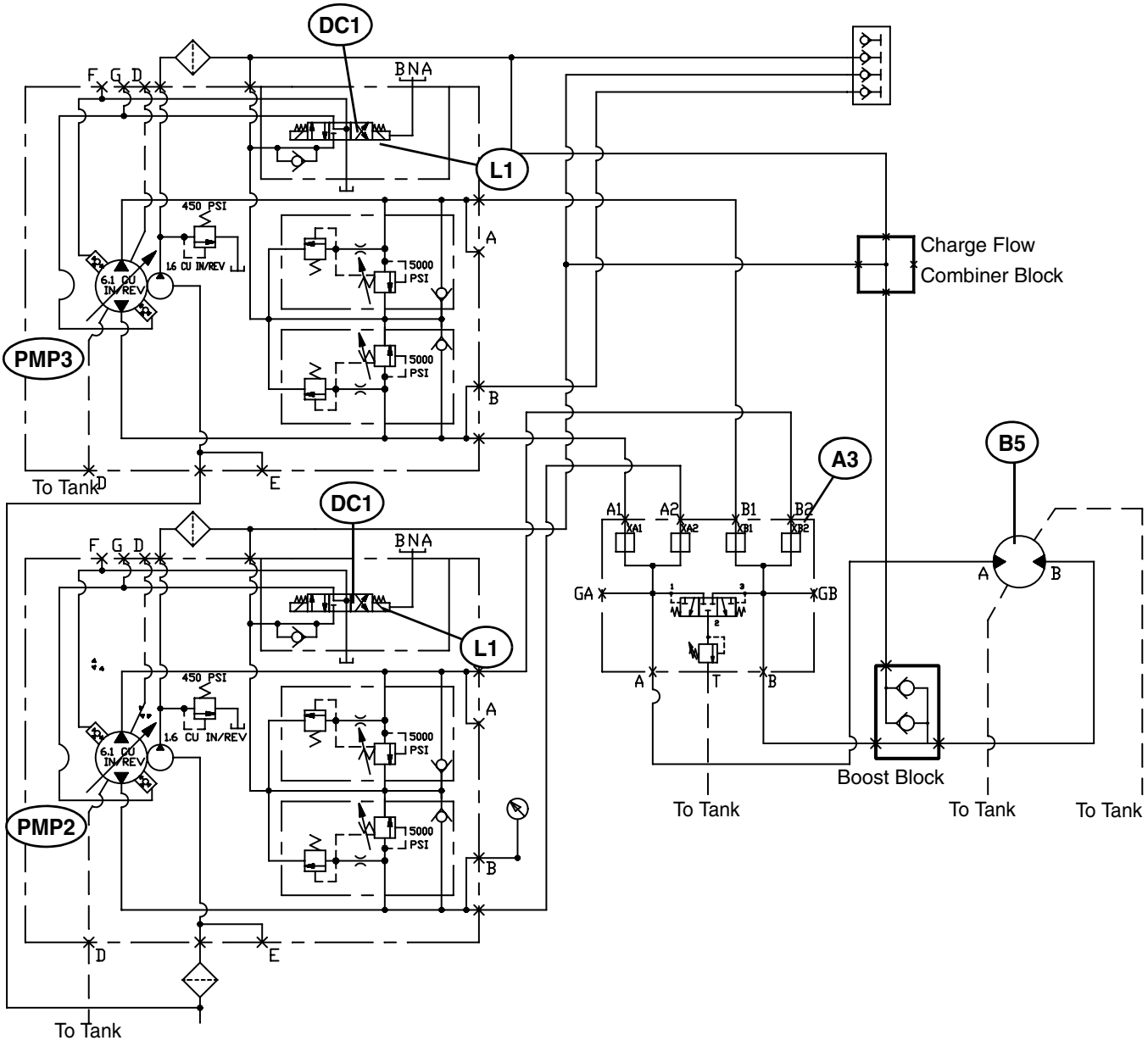
Direction control is actuated when switch S1 is pushed or pulled from the NEUTRAL position. When direction switch is actuated, the microprocessor supplies variable current depending on the position of speed knob R1, to the attachment pump EDCs (electronic displacement control) DC1L1.

The current flows through the EDCs in one direction for FORWARD and in the opposite direction for REVERSE. The more R1 is turned clockwise, the more current delivered, therefore the faster the motor A5 will turn.



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Pumps PMP2 & PMP3



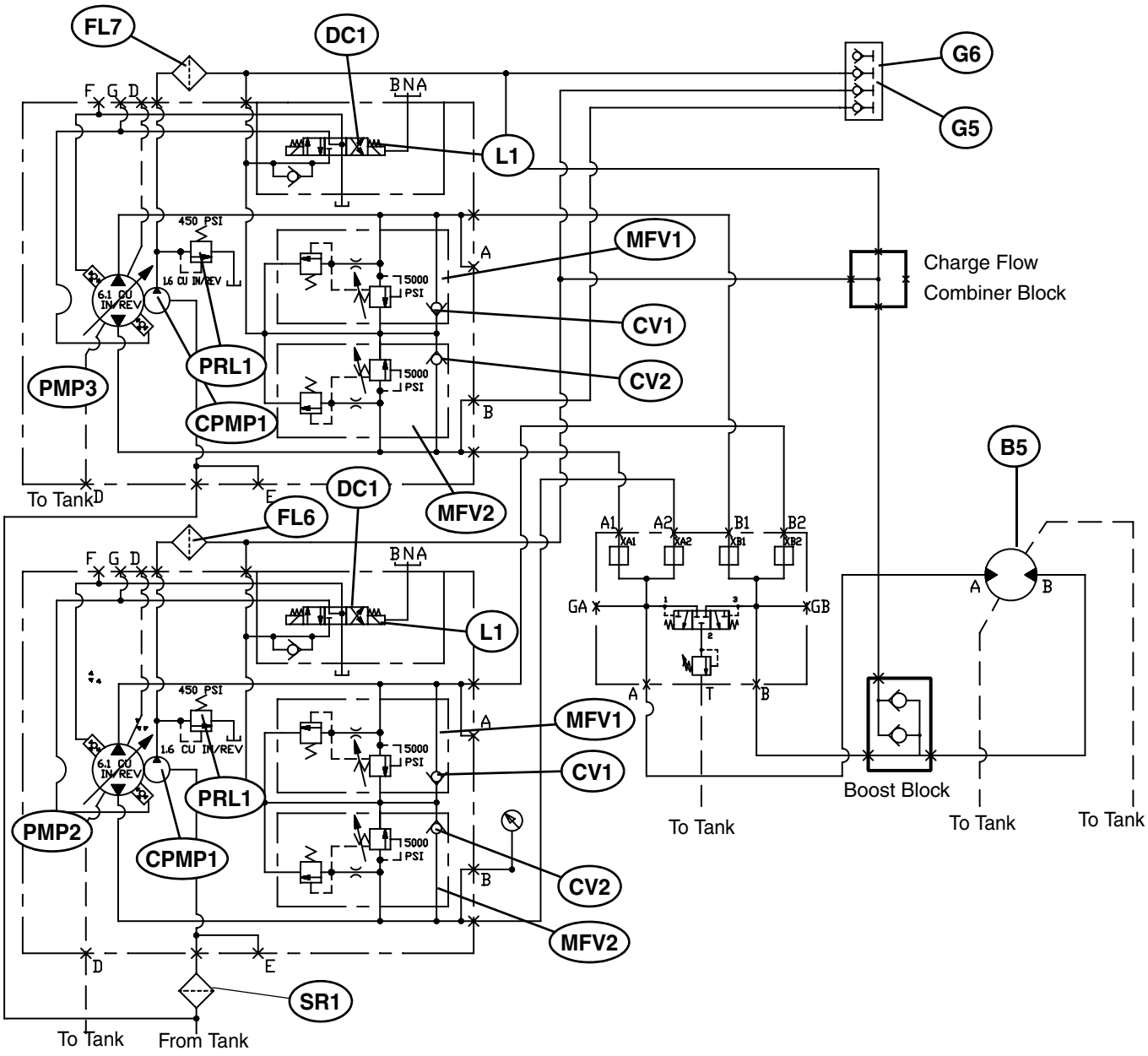
EDC (Electronic Displacement Control)

Once the operator actuates the attachment control FORWARD/REVERSE switch, the EDCs L1 convert the DC electrical signal from the microprocessor into a hydraulic signal which operates a spring-centered, 4-way directional servo valve DC1 intregal to pumps PMP2 & PMP3. The valve ports pressurized oil to either side of a dual acting servo control piston.

The servo piston rotates the swashplate to vary the pumps displacement from full displacement in one direction to full displacement in the opposite direction. The pump provides oil flow from either the A or the B port to the attachment manifold A3 and drive motor B5 to allow bi-directional operation of the motor.

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Charge Pressure Circuit



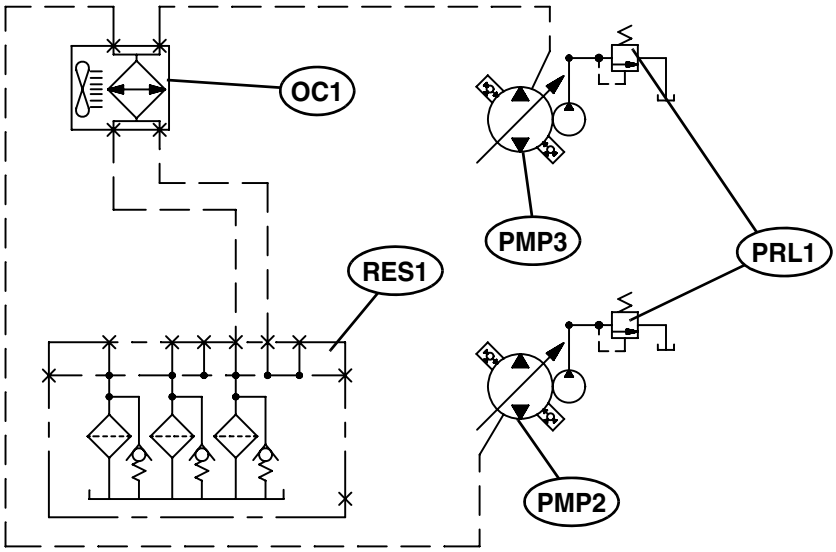
A charge pump CPMP1 is installed in the main pumps PMP2 & PMP3 and driven off the main pump shaft. The charge pump is necessary to:

- supply cool oil to the system
- maintain positive pressure in the main system loop
- provide pressure to operate the control system
- make up for internal leakage

Continued on next page...

The charge pressure must be present under all conditions of operating to prevent damage to the system. The charge relief valve PRL1 on the pumps serves to maintain maximum charge pressure at a setting of 450 psi (31 bar).

Oil is forced by atmospheric and oil tank pressure through a suction screen SR1 installed in the oil tank to charge pumps CMP1. The charged oil flows through low pressure charge filters FL6 & FL7, through system check valves CV1 & CV2 which are intregal to the multifunction valves MFV1 & MFV2, through a charge flow combiner block, shuttle manifold and boost block to fill both sides of the loop.



When the closed loop is full of oil, The remainder of oil goes across the charge pressure relief valve PRL1, to pump cases, through oil cooler OC1, then and back to the tank RES1.

The charge pressure is present at the diagnostic ports G5 & G6 for checking the charge pressure for left and right attachment drive circuits. Charge flow is also combined at the combiner block and directed to the boost block of manifold.

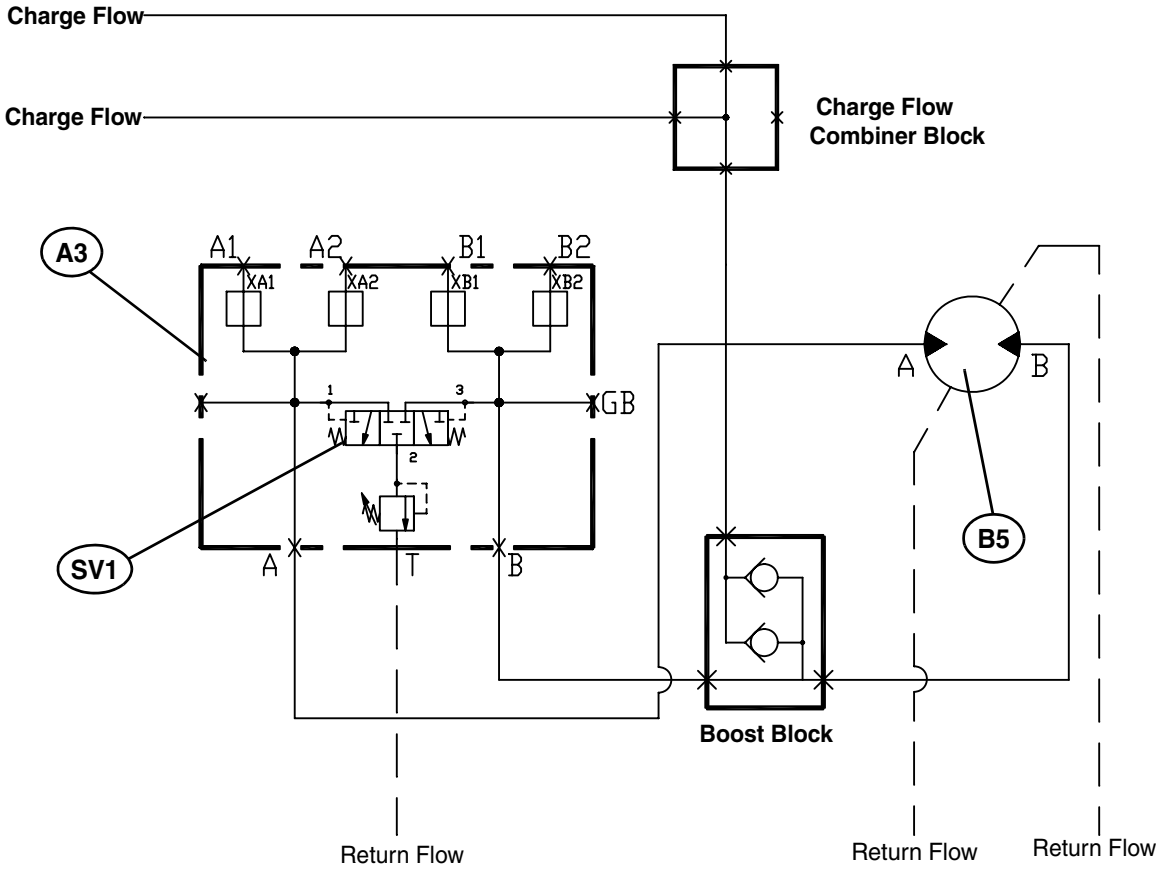
Multifunction Valves MF1 & MF2

The multifunction valves MFV1 & MFV2 used in each closed loop port, limit system pressure and allow charge oil to keep the closed loop filled. The multifunction valves incorporate the system check valve, high pressure relief valve, and bypass valve in a replaceable cartridge.

When the preset pressure, 5000 psi (345 bar) is reached in the main loop, the high pressure relief valve acts to immediately limit system pressure by cross-porting system flow to the low pressure side of the loop.

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Attachment Manifold A3 and Drive Motor B5



High Pressure Circuit

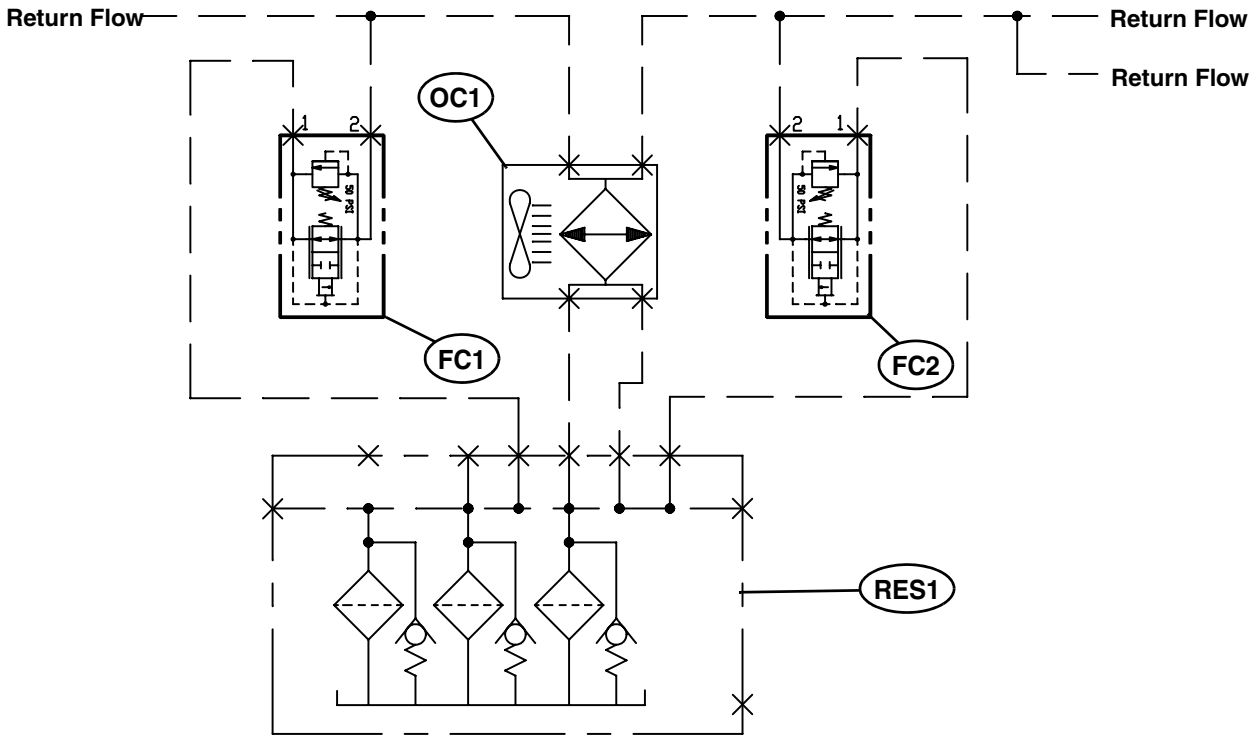
As soon as the pump swashplate moves off center position, oil flows out of pumps, through the high pressure side of the closed loop to the attachment manifold A3. The oil flow from both pumps is combined in the manifold then directed to the bi-directional motor B5, causing it to rotate. The resistance created by the oil flow through the motor begins to build pressure which in turn causes the shuttle valve SV1 inside attachment manifold to shift.

Shuttle Valve SV1

It is necessary in a closed loop hydraulic system to remove approximately 10–15% of the oil flowing through the loop for cooling and filtering on a continuous cycle. The equivalent amount of oil leaving the loop is replenished into the loop by the charge pump.

The shuttle valve SV1 provides a secondary flow path, on the low pressure side of the closed loop, which allows this percentage of oil to flow back to the tank.

Continued on next page...



Thermal Bypass Valves FC1 & FC2

Case drain flow from both pumps as well as the flow from the shuttle valve in attachment manifold is directed through thermal bypass valves FC1 & FC2 and returned to tank RES1.

The thermal bypass valves control direction of oil flow based on the temperature of the oil.

The thermal bypass valves operate as follows:

- When oil temperature is below 130°F (54°C), the valve routes return oil from the valve directly to the tank.
- When oil temperature rises above 130°F (54°C), the valve starts to shift. The return oil is allowed to flow to both the tank and the oil cooler OC1.
- When oil temperature reaches 150°F (66°C), the valve has fully shifted and routes all oil to the oil cooler OC1.

Pressure Relief Operation

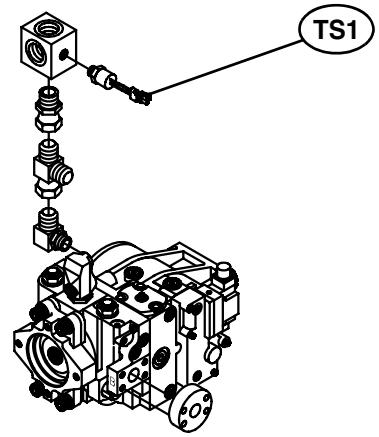
The thermal bypass valve incorporates a normally closed relief valve PRL1. If pressure through the cooler exceeds 50 psi (3 bar), the valve shifts, routing a portion of the oil flow directly to the tank.

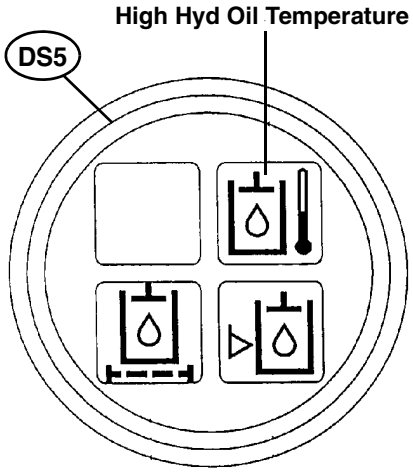
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Hydraulic Oil Temperature Switch TS1

If the oil temperature in the system rises beyond 200°F (93°C), an oil temperature switch TS1 installed in a block on the right attachment pump will close, sending a signal to the hydraulic light cluster DS5. The indicator light will illuminate to warn the operator of the situation.





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Chapter 8: Attachment Subsystem

Section B: Troubleshooting

OVERVIEW



WARNING: Pressurized fluid can penetrate body tissue and result in serious injury or death. Leaks can be invisible. Keep away from any suspected leak. Relieve pressure in the hydraulic system before searching for leaks, disconnecting hoses, or performing any other work on the system. If you must pressurize the system to find a suspected leak, use an object such as a piece of wood or cardboard rather than your hands. When loosening a fitting where some residual pressure may exist, slowly loosen the fitting until oil begins to leak. Wait for leaking to stop before disconnecting the fitting. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

Pretest Inspection

Before beginning any troubleshooting, review information in the General Information Chapter under *"Troubleshooting Guidelines," page* **1-9**.

If a malfunction occurs, do the following visual checks to inspect for obvious signs of failures before any testing is performed.

- Check for any obvious mechanical failures such as, broken linkages, cables, sprockets, chains, sheaves, pulleys, belts, and so on.
- Check the level of hydraulic oil in tank. Check hydraulic circuits for any obvious failures such as, broken, kinked, loose, or leaking hoses and fittings on supply, pressure, and return to hydraulic components. Also, check for broken, missing, corroded, or loose connections and wires that supply ground and power to electrical components.

Correct any problems found during the inspection. Operate the machine to verify the malfunction is fixed.

Fault Charts

If no problems were found during the pretest inspection, refer to the fault charts starting on page **8B-3** and continue troubleshooting. The possible malfunctions listed do not cover everything that could go wrong with the circuits. They are meant to give a technician a logical place to begin, based on performance observations.

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Test Equipment Needed

IMPORTANT: The pressure and flow ratings of the test equipment used to conduct the following hydraulic test procedures must be equal to, or greater than the pressure and flow ratings of the circuit being tested.

- Pressure Gauge
- Vacuum Gauge
- Phototachometer
- Flow Meter
- Pyrometer
- Digital Multimeter

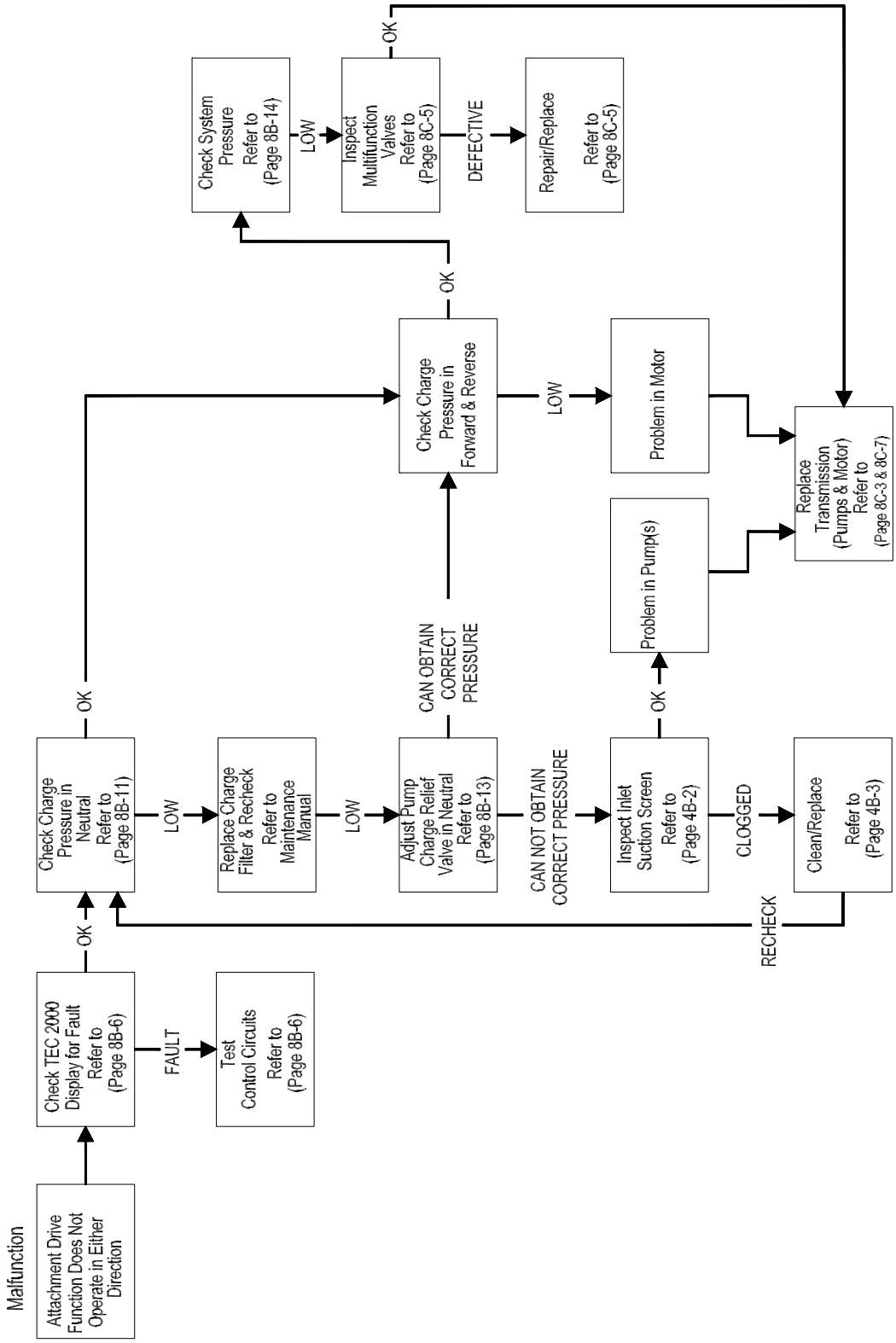
Component Repair/Replace

If troubleshooting procedures determine a component is in need of repair or replacement, refer to section C for the appropriate repair procedures for those components.

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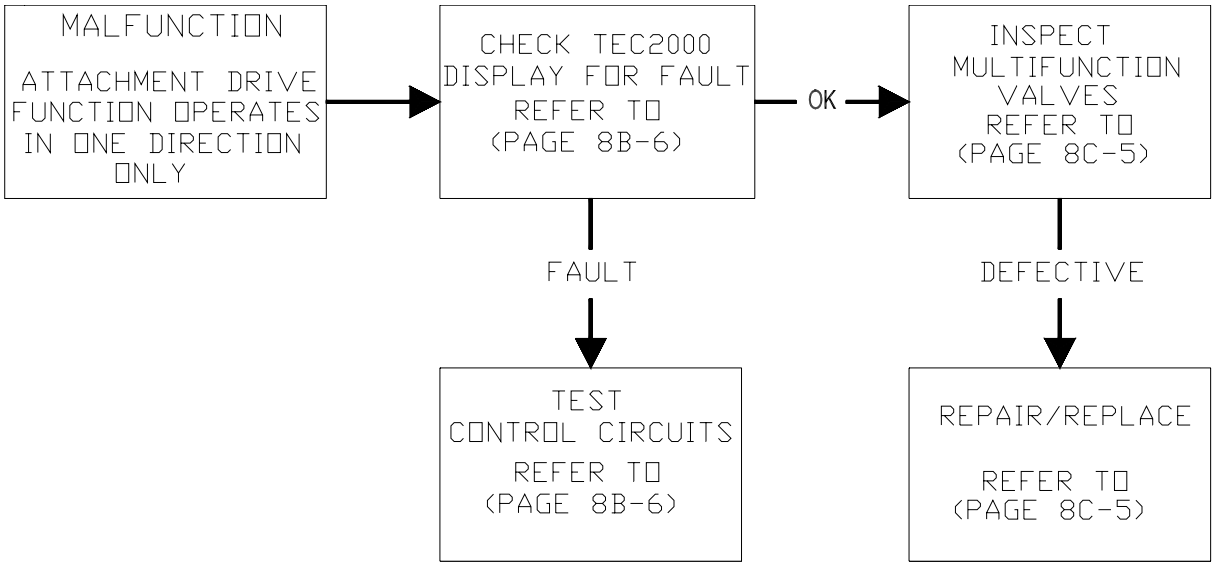
FAULT CHARTS

Attachment Drive Function Does Not Operate in Either Direction



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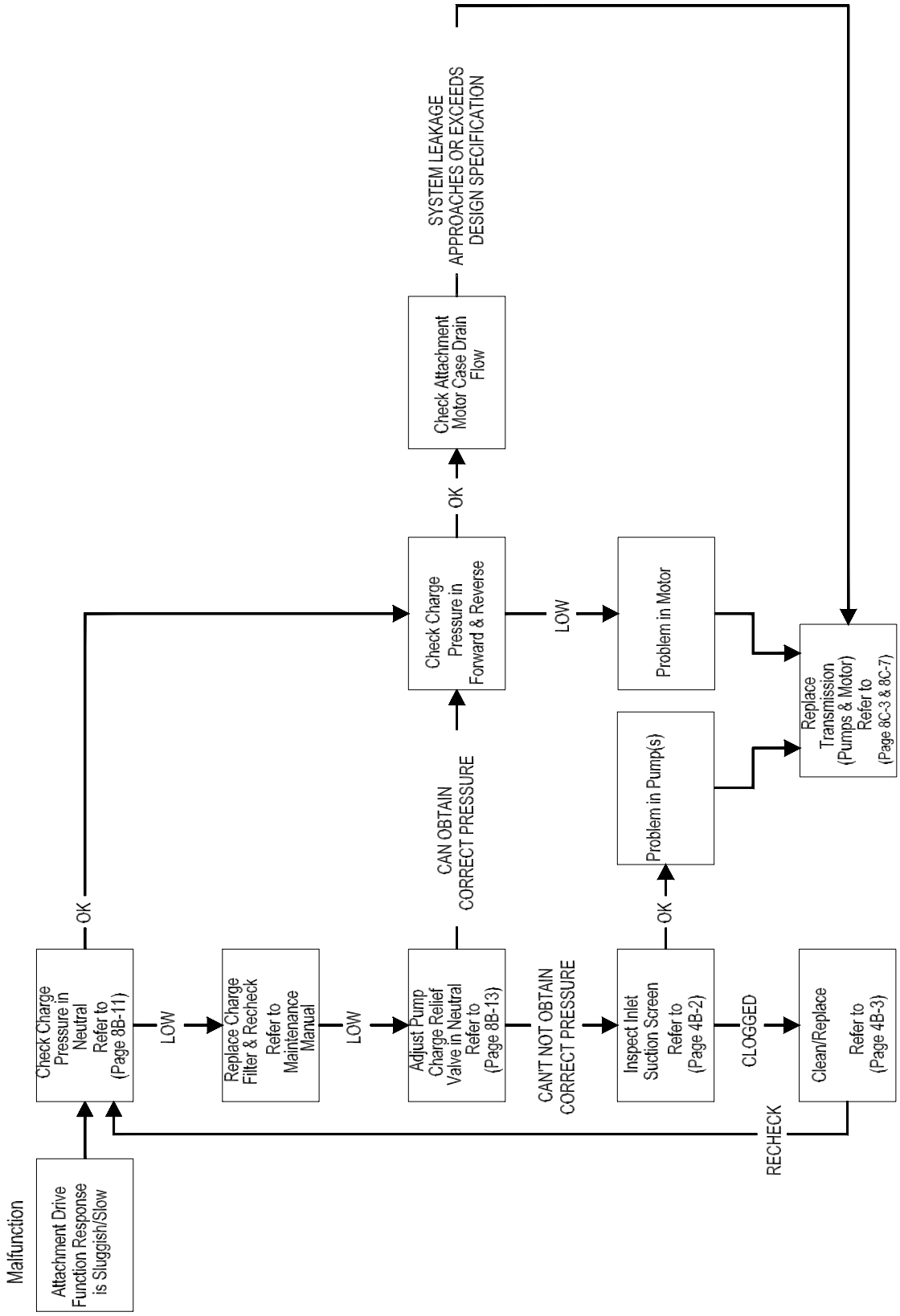
Attachment Drive Function Operates in One Direction Only



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Attachment Drive Function Response Is Sluggish/Slow in Both Directions



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ATTACHMENT DRIVE CIRCUIT

Attachment Control Circuits/Components

The attachment drive circuit is controlled using the microprocessor (TEC 2000). The MAP on page **8B-8** shows the relationships of the attachment drive control circuits and components. The lines and arrows represent the inputs and outputs to and from each component.

TEC 2000 Microprocessor

The TEC 2000 microprocessor view screens display information received from inputs and outputs of the various electrical control components. The view screens indicate the current operating parameters for voltage, amperage and RPM.

When a parameter is out of range, the microprocessor will display a fault to indicate a control is malfunctioning. The various faults associated with the attachment control circuits are listed below.

Troubleshoot appropriate control circuits/components according to the faults experienced. On page **8B-7** is a troubleshooting table listing some general areas to check when troubleshooting.

Display Faults

TEC 2000 FAULTS	DESCRIPTION
SENSOR POWER	Measured sensor power voltage is not within 4.75V to 5.25V.
ATTACH SPEED POT	Attachment Speed Pot reading is more than 0.1V outside the calibrated range (left stop to right stop).

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Troubleshooting Table

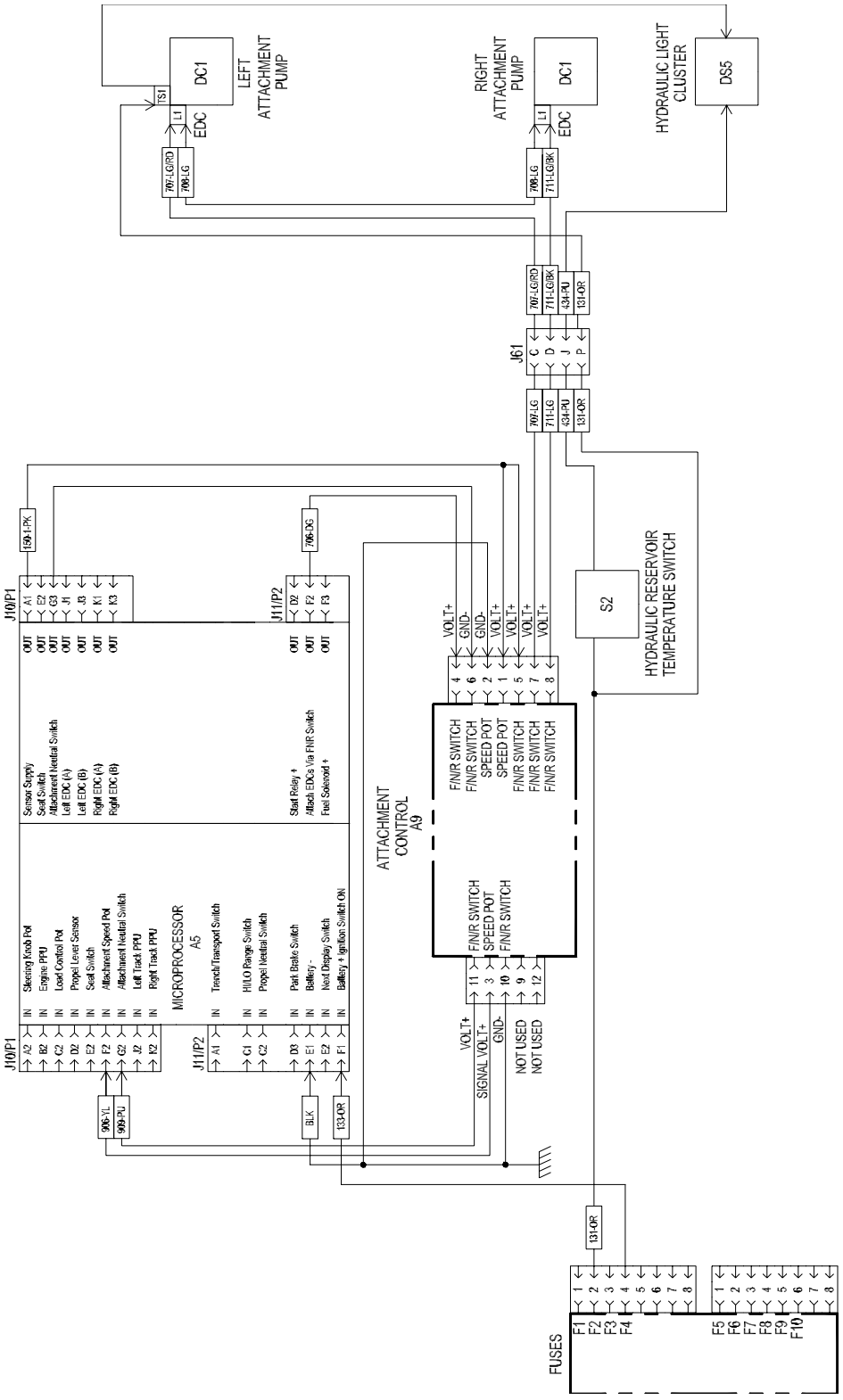
Use table below for indications on where to test the circuits. Refer to the following pages for information on testing the control circuits. Use the reference MAP, and wire harness diagram for reference when testing.

TEC 2000 FAULTS	TROUBLESHOOTING CHECKS
SENSOR POWER	Usually caused by a potentiometer being shorted to ground. • Check battery voltage. • Check wiring harness. • Check connections coming from the battery voltage to the microprocessor for shorts or opens. • Check voltage supply line coming into the microprocessor.
ATTACHMENT SPEED POT	• Display attachment speed knob view screen and look for voltage change while moving the attachment speed knob. This will ensure voltage signal to microprocessor (normal range 0.5–4.5V). • Recalibrate attachment speed knob. • Check connection between attachment control and the microprocessor. • Check attachment control and look for faulty wiring or potentiometer.

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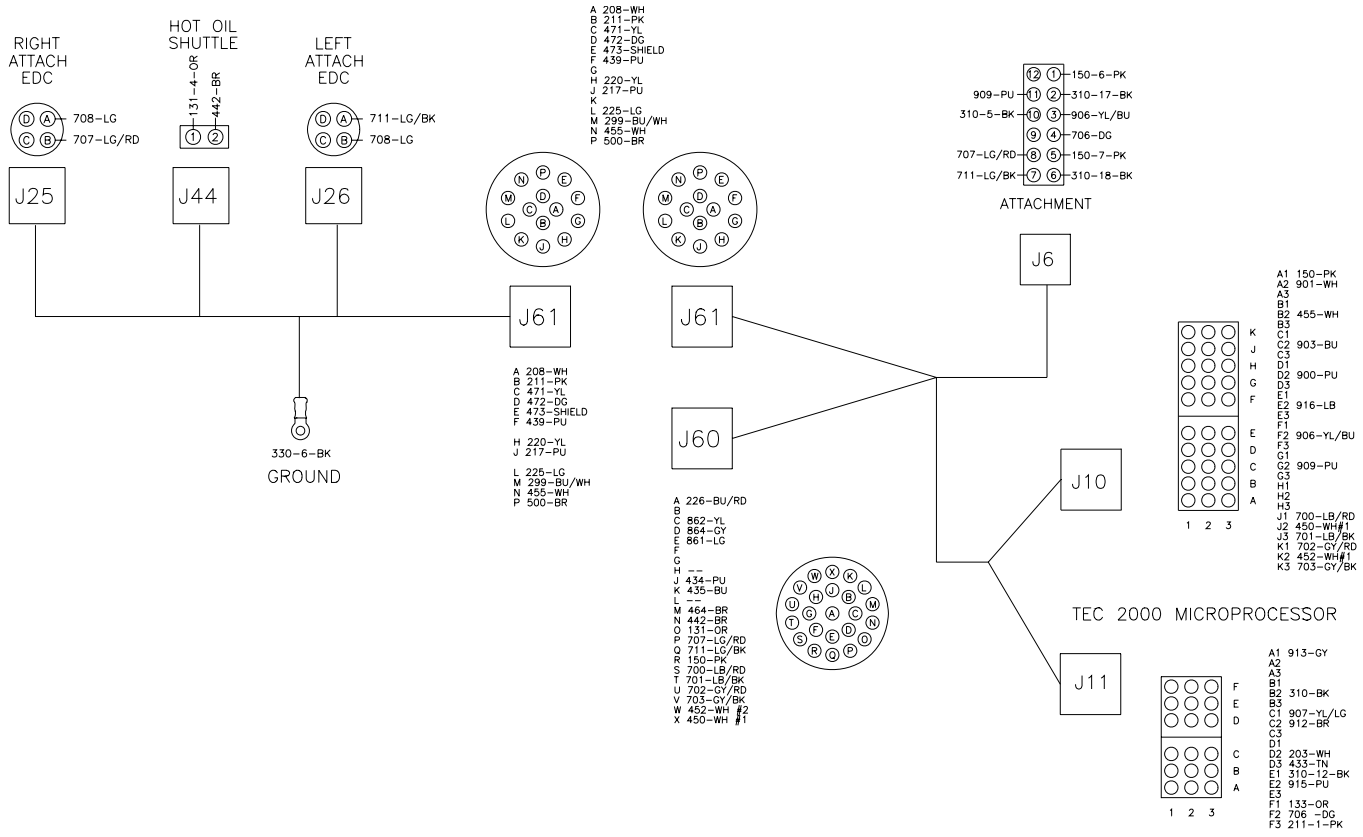
Testing Control Circuits

Control Circuits
MAP



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Component Pin/ Terminal Reference



The diagram above represents the wire harness connections of the attachment control circuits components. Use diagram for pin, terminal, wire, and plug reference when testing circuits and components. Only the wire harness connections relevant to the attachment control circuits are represented.

Complete wire harness diagrams and schematics are located in the Addendum section at the back of the manual if needed for reference. For more detailed information on the TEC 2000 microprocessor pin designations and functions, refer to Chapter 2, System Information.

The following procedures are used to test for opens, shorts or high resistance in the circuit. Compare test results with the normal parameters listed in the troubleshooting table on page **8B-7**. If component(s) are not within the normal parameters given, they need repaired or replaced.

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Open Circuit Test

1. Test for an open in the circuit by testing for acceptable voltage on input and output pins/terminals of plugs and components. The control circuits MAP on page 8B-8 illustrates what the TEC 2000 microprocessor is inputting and outputting to and from the circuits. Testing at these points, working through the circuit, will isolate the failed component(s) by process of elimination. Continue through the circuit until the open is found.

   Expected result: When the positive lead is placed before an open point, the meter will read voltage. When the lead is placed beyond the open, the meter will read no voltage, indicating that a complete circuit exists from the chassis ground to the point where voltage is last seen in the circuit.

2. Once the open is found, turn ignition switch OFF, unplug wire harness at the suspected component and test component for continuity or specified resistance. If the component is OK, test wires, plug connections, connecting the component for continuity. Replace faulty component or section of wire harness. If voltage is measured at all test points, proceed by measuring for voltage on ground side.

3. Normal voltage should measure 0.0–0.5 volts. If battery voltage is measured on ground side, a poor connection or broken wire/cable is indicated. Test wires connecting the component for continuity. Replace faulty section of wire harness.

High Resistance Test

Measurements taken from a multimeter can be used to troubleshoot for unwanted resistance. Use multimeter to test for lower than normal battery voltage (voltage drop) while moving to accessible points in the circuit wiring. Replace section of failed wire harness. Refer to the diagram on previous page.

Short Circuit Test

1. Test for a short in the circuit. When testing the circuit for a short, turn the ignition switch OFF and set the multimeter to measure resistance (ohms). Work through the circuit, if the meter measures resistance through the complete circuit, it may be an intermittent problem causing the short. In that case, repeat procedure and move wiring harness or tap on components while watching for a sudden drop in resistance Ω

   Expected result: If the voltage side of the circuit is shorted to ground, the meter will read 0.0Ω This indicates there is no resistance between check points (a dead short). Work through the circuit until the short is located. When the short is removed the meter will return to a resistance reading.

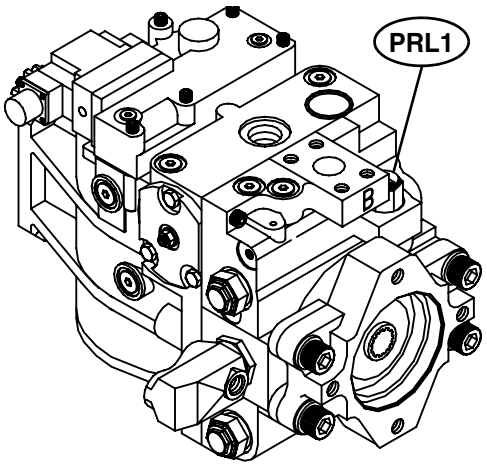
2. Repair or replace faulty component or section of wire harness. Check circuit for function.

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Attachment Drive Hydrostatic Circuit

Charge Pressure

The pressure in the hydrostatic system must be known to quickly and accurately troubleshoot the system. Diagnostic fittings located on the side of the machine are provided to check various pressures.



Insufficient charge pressure will result in inadequate or poor attachment drive performance.

The charge relief valve PRL1 on the pumps serve to maintain charge pressure at the specified setting. This normal setting assumes the pumps are in NEUTRAL (zero flow); in FORWARD or REVERSE charge pressure will be slightly lower.

Charge Pressure - Quick Check

Snubbers are recommended to protect the pressure gauges. Gauge calibration is necessary to insure accurate readings. A diagnostic pressure gauge, part number 67566001, is available from Vermeer. This is a 2-stage pressure gauge rated for 7500 psi (520 bar).

To check combined charge pressure of the attachment drive system:

1. Install pressure gauges capable of at least 500 psi (35 bar) in the left and right attachment pump charge pressure diagnostic gauge ports located on the side of machine.
2. Start engine and set throttle speed to (2200 rpm).
3. Ensure attachment drive switch is in NEUTRAL.
4. Ensure hydraulic oil is warmed to at least 100°F (38°C).
5. Observe gauges in NEUTRAL.

   Expected result: The diagnostic pressure gauges should read 350 psi ± 10 (24 bar ± .07).
6. If charge pressures are not within specification, replace remote charge filters. Refer to the T655III *Maintenance Manual for* instructions on replacing filters.

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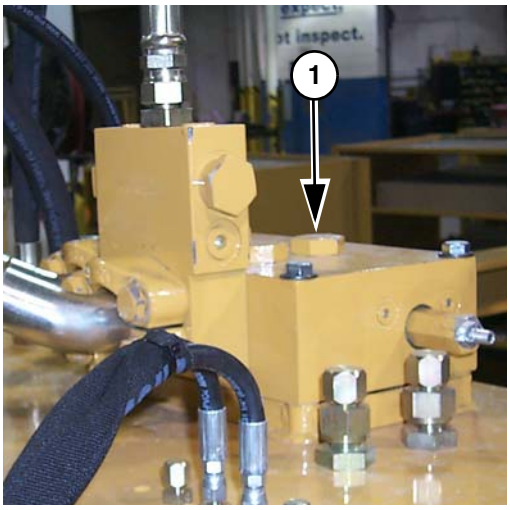
7. Recheck charge pressure. If charge pressure is still too low, refer to the individual pump check below. If charge pressure is correct, move the attachment drive switch out of NEUTRAL and check the FORWARD and REVERSE pressure.

   Expected result: The pressure should drop to 350 psi (24 bar). This is the setting of the hot oil shuttle valve relief. If pressure is incorrect, the shuttle pressure must be set after first checking and/or adjusting the system pressure. Refer to page **8B-14** for procedures on checking and setting these pressures.

Individual Pump - Check

To check the charge pressure of each individual pump:

1. Remove the existing four plugs **(1)** in the manifold and replace with four special flow blocking plugs (Vermeer P/N 613939001). Retain original plugs for reuse after check.



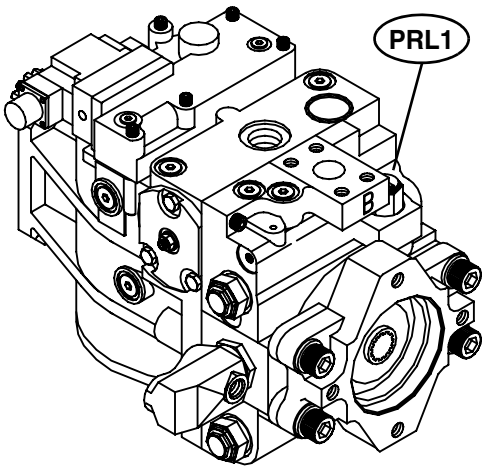
2. Install pressure gauges capable of at least 500 psi (35 bar) in the left and right attachment pump charge pressure diagnostic gauge ports located on the side of machine.
3. Start engine and set throttle speed to (2200 rpm).
4. Ensure attachment drive switch is in NEUTRAL.
5. Ensure hydraulic oil is warmed to at least 100°F (38°C).
6. Observe gauges.

   Expected result: The diagnostic pressure gauges should read 450 psi ± 10 (31 bar ± .07). If one or both charge pressures are incorrect, adjust charge pressure while in NEUTRAL. See following page.

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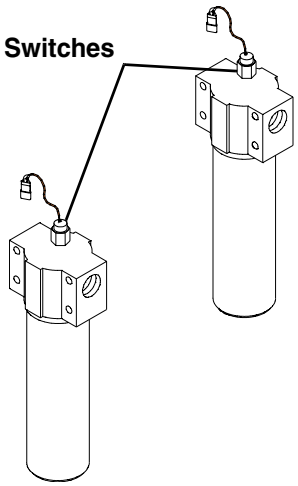
Charge Pressure - Adjust

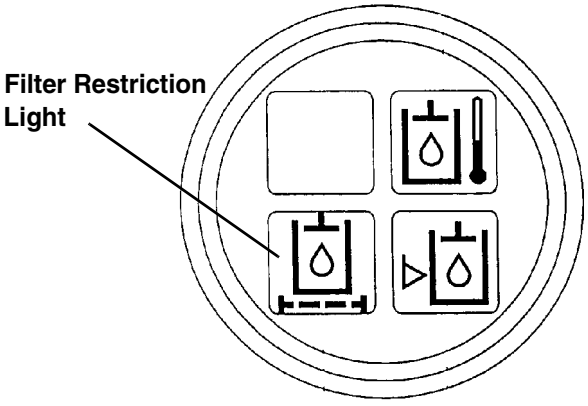


1. Adjust by loosening hex nut of charge pressure relief valve PRL1 of the appropriate pump. Turn adjustment screw clockwise to increase pressure, counterclockwise to decrease pressure.
2. If correct charge pressure cannot be obtained through adjustment, refer to page **4B-2** of the Fluid Conditioning subsystem and inspect the suction screen. If clogged, clean or replace screen then recheck charge pressure.
3. If the suction screen is OK, most likely there is a problem in the charge pump or charge relief valve of the pump(s) not responding. Replace pump(s). Refer to repair section for information.
4. Follow *"Shutdown Procedure," page* **2-1**.
5. If checking system pressure, do not remove the charge pressure gauges or special plugs at this time. If not checking system pressure, remove charge pressure gauges and special plugs from manifold and install original plugs in their place.

Charge Pressure - Filter Switches

Attachment charge filters have a pressure switch in the filter head. The switch connects to the filter restriction light. If pressure differential is too great across the filter, the indicator light on the dash will trip. This light is also used for return filter restriction.



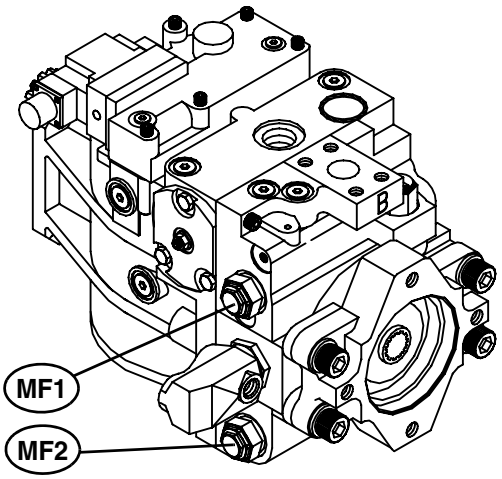


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System Pressure

Multifunction valves MF1 & MF2 located on the pumps are used to set the system high pressure relief.

NOTE: The valves are set at the factory and should not need adjusted unless they are repaired or replaced with new ones. Refer to page 8C-5 for information on adjusting.



System Pressure - Check

Attachment drive system pressure can be monitored with the pressure gauge in the control panel. Maximum system pressure is 5000 psi (345 bar).

Individual Pump - Check

To check the high pressure of each individual pump:

1. Install a pressure gauge capable of at least 5000 psi (345 bar) in the right attachment pump high pressure diagnostic gauge port located on the side of machine.

   The left attachment pump high pressure gauge is located on the control panel.

2. Ensure attachment drive switch is in NEUTRAL. **Blocking plugs must be installed for this test**.

3. Start engine and set engine speed to full throttle (2350 rpm).

NOTE: Do not stroke pumps for more than 10 seconds. Hydraulic oil will be passing over the relief valves and heating up rapidly. Blocking Plugs must be installed to achieve system pressure.

4. Push attachment switch to FORWARD drive and adjust speed control knob until engine is lugged to approximately (2200 rpm). Observe the pressure on both attachment gauges.

   Expected result: Both gauges should read approximately 5000 psi +200/-0 (345 bar). If not, return attachment switch to its NEUTRAL position, decrease engine speed to idle and shut down engine.

5. Refer to page 8C-5 of repair section and inspect multifunction valves of the pump(s) that is incorrect for damage or contamination. Repair or replace and as necessary. Adjust shuttle valve pressure per instructions given.

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Attachment Motor Case Drain Flow Test

If attachment drive circuit response is sluggish, slow, or running hot but is otherwise working, the motor and pumps may be worn beyond their useful life or contamination may have prematurely caused the components to wear beyond design specification.

Oil Sampling

A closed-loop system should not be opened when testing so no additional contamination is introduced into the system. Therefore, before installing any test equipment to determine component wear. The first step would be to obtain an oil sample from the closed loop.

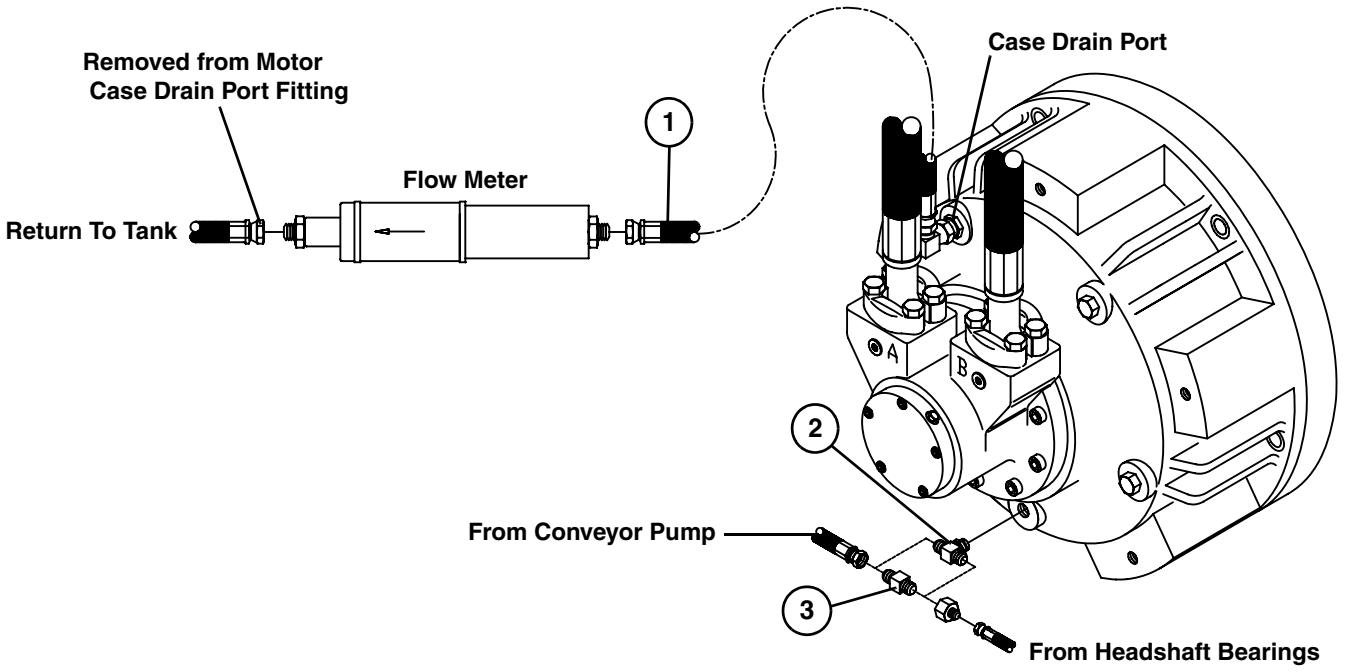
Oil sampling systems can analyze the oil without interrupting machine operation or opening the system. The oil sampling system can determine oil viscosity, temperature, particle size, type, and concentration of contamination.

1. Refer to page **4B-5** of the Fluid Conditioning subsystem troubleshooting section for oil sampling criteria and procedures. If oil sample test is not within the acceptable range, follow instructions given. If the oil sample test is within the acceptable range, continue with step 2 and test the condition of the closed-loop transmission by measuring the motor case drain flow for excessive leakage.
2. Shut down engine.
3. Turn ground disconnect switch to the DISABLE position.

IMPORTANT: Ensure any hoses or fittings that are added to the test equipment are the same size and rating as hoses and fittings installed in the hydraulic circuit. Mismatched hose or fitting sizes can result in erroneous pressure indications. Mismatched pressure ratings can result in leakage or personal injury.

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4. Remove existing case drain line from motor and install it to the outlet of a 50 gpm flow meter. Ensure meter direction arrow is pointing away from the motor.
5. Add a short hose **(1)** from the case drain port of the motor to the inlet of the flow meter.

NOTE: The flushing circuit must be removed from the motor to get an accurate case drain reading.

6. Remove hydraulic lines coming from conveyor pump and headshaft bearings from the existing T-fitting **(2)**.
7. Install lines to a straight coupler fitting **(3)**. This will direct the flushing oil from conveyor pump to just the headshaft bearings.

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8. Turn ground disconnect switch to the ENABLE position. Start engine and inspect test equipment connections for leaks.
9. Allow system to warm up to approximately 130°F (54°C). If needed, cycle a machine function to aid in warming the oil.
10. Set engine speed to full throttle (2350 rpm).
11. Lower boom into trench to achieve system pressure.
12. With chain rotating forward, system pressure should achieve approximately 4000 psi (275 bar). As each cylinder passes, leakage should not exceed approximately 4 gpm (19 L/min).

Analyzing Motor Test Results

IMPORTANT: Motor wear is caused by contamination in the oil and degradation of the oil. Since the pumps and motor in the closed loop continuously recycle the same oil, the pumps and motor wear at the same rate. If leakage in a motor approaches or exceeds the design specification, it is highly recommended that the transmission (motor and pumps) be replaced.

13. At conclusion of test procedure, remove test equipment and reconnect hydraulic lines to the original fittings.

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Chapter 8: Attachment Subsystem

Section C: Repair

INTRODUCTION

Components

This section consists of repair procedures including the removal, replacement, installation, repair, and adjustments of those hydraulic and mechanical components responsible for operation of the trencher drive.

Hydraulic:

- Pumps PMP2 & PMP3
- Motor B5
- Manifold Valve Assembly A3

Mechanical:

- Digging Chain
- End Idler Assembly
- Headshaft Assembly

HYDRAULIC REPAIR

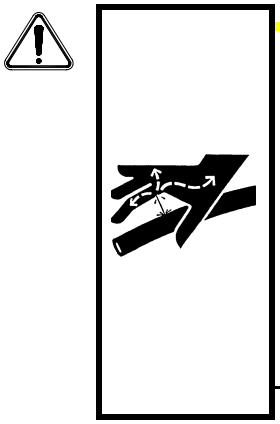
General Guidelines When Servicing the Hydrostatic Drive

The hydrostatic drive components are precision-built to very close tolerances and operate at very high pressures. Cleanliness is extremely important, when servicing a hydrostatic system. Use care to avoid allowing dirt, dust or debris to enter the hydraulic system. Contaminated oil will ruin the pump and motor in a short amount of time.

Continued on next page...

Avoid Oil Contamination

Before Repairing (Opening the System):



WARNING: Pressurized fluid can penetrate body tissue and result in serious injury or death. Leaks can be invisible. Keep away from any suspected leak. Relieve pressure in the hydraulic system before searching for leaks, disconnecting hoses, or performing any other work on the system. If you must pressurize the system to find a suspected leak, use an object such as a piece of wood or cardboard rather than your hands. When loosening a fitting where some residual pressure may exist, slowly loosen the fitting until oil begins to leak. Wait for leaking to stop before disconnecting the fitting. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

Warranty claims may be denied if damage is caused by contaminated hydraulic fluid.

1. Clean dirt from hose connections and around pump and motor ports before loosening any connection.
2. Use new, clean plugs to plug disconnected hoses. If clean plugs are not available, place plastic bags (such as sandwich bags) over the ends of hoses and hold them in place with rubber bands. Also use new clean caps to cap off fittings.

The hydrostatic system can be easily damaged by contamination or lack of oil during start up. After repairing a hydrostatic system, use the following procedure to assure there is an adequate supply of filtered oil to each part of the system:

After Repairing (Returning the System to Service):

1. All oil supply components (tank, hoses, tubes, fittings) must be clean. If possible, use a foam projectile cleaning system. Otherwise, rinse all components with clean solvent (solvent must be filtered through a 10-micron filter), and dried with filtered air before installation.
2. Fill oil tank with the recommended hydraulic oil. If replacing a pump or motor, fill case with oil before starting the machine. Filter oil with a 10-micron oil filter as it is added to the tank, pump, or motor. Do not reuse old hydraulic oil.
3. Install filter kit IK-349 on the circuit. Refer to the kit instructions to flush the system. Pump and motor cases must be full of oil before turning engine over.

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4. Whenever a hydrostatic system has been opened, crank engine without allowing it to start until charge pressure is 25–50 psi (172–345 kPa). This can be accomplished by removing power wire from the engines run relay. This will keep the engine from starting.
5. Turn ignition switch to START to crank the engine. When charge pressure of 25–50 psi (172–345 kPa) is established, return ignition switch to OFF and reconnect fuel solenoid power wire.
6. Start engine.
7. Do not run a new motor over half speed until the motor has been worked under full load.
8. Take an oil sample from the closed loop whenever replacing components or before setting high pressure relief valves. Refer to page **4C-5** of the Fluid Conditioning Troubleshooting section for oil sampling criteria.
9. Refer to *"Calibration," page* **2C-25** in System Information Chapter and follow instructions given for re-calibrating the microprocessor.

Attachment Drive Pumps PMP2 & PMP3

The pumps can be replaced as a complete unit or partially serviced. The multifunction valves, control EDC, charge pressure relief valve, and shaft seals are serviceable.

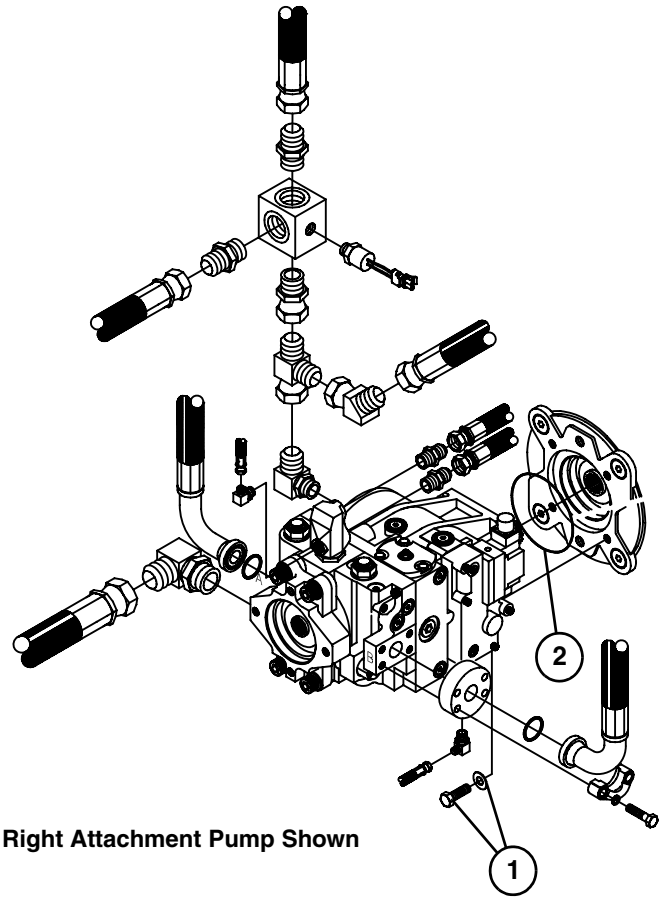
Remove

To remove a pump:

1. Follow *"Shutdown Procedure," page* **2C-1**.
2. Before working on the hydraulic system, release pressure in the oil tank by loosening filler cap.
3. Refer to page **8C-1**. Read general guidelines when servicing.
4. Remove cross conveyor assembly. Refer to page **9C-9** for removal instructions.
5. Label and disconnect each hose from pump. Plug all hoses and ports; cap all fittings.
6. Unplug wire harness connector from EDC.
7. Drain oil from the pump drive gearbox.

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Right Attachment Pump Shown

8. Remove four bolts and washers **(1)**.
9. Using a suitable lifting device, pull pump straight off pump drive gearbox.
10. Remove O-ring **(2)** from pump. If damaged, replace before installing new pump.

Install

Reverse removal procedure to install new pump. Be sure to install O-ring between pump and gearbox.

- Add oil to the pump drive gearbox. Fill between add and full marks on dipstick. Refer to *"Fluid and Lubricants," page* **2C-7** for oil requirements.
- Apply Molykote G-N paste (P/N 94469003) to spline of pump shaft, and pump drive.
- Torque bolts **(2)** according to standard torque charts.
- Read and follow instructions in (Returning the System to Service) on **page 8C-2** before starting engine.

Pump EDC (Electric Displacement Control)

Replace/Repair

Refer to Ground Drive subsystem repair section *"Pump EDC (Electric Displacement Control)," page* **7C-7**. The procedures are the same.

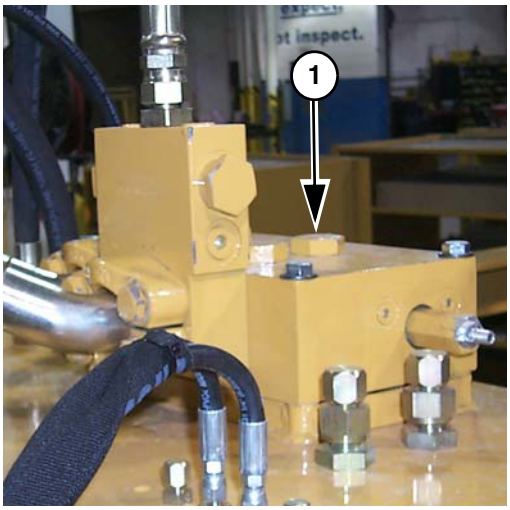
Pump Multifunction Valves

Replace/Repair

Refer to Ground Drive subsystem repair section "Pump Multifunction Valves," for repair procedures. The procedures given are the same for the attachment pumps. After repair, check and adjust if necessary the high pressure relief and shuttle valve pressure relief. See below.

High Pressure Relief - Adjust

NOTE: The following procedure refers to setting the high pressure in the FORWARD drive multifunction valves. Repeat the procedure for setting the REVERSE drive multifunction valves.

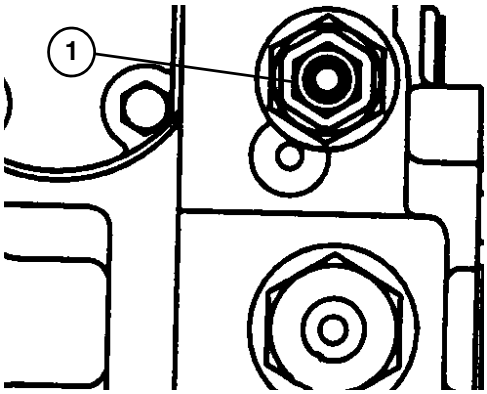


1. Remove four plugs **(1)** in the manifold and replace with four special plugs (Vermeer P/N 613939001). Retain the original plugs for reuse after check.
2. Install pressure gauges capable of at least 500 psi (35 bar) in the left and right attachment pump charge pressure diagnostic gauge ports located on the side of machine.
3. Install a pressure gauge capable of at least 5000 psi (345 bar) in the right attachment pump high pressure diagnostic gauge port located on the side of machine.

   The left attachment pump high pressure gauge is located on the control panel.
4. Ensure attachment drive switch is in NEUTRAL.
5. Start engine and set speed to full throttle (2350 rpm).

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6. Loosen lock nut **(1)**. This is the smallest hex on multifunction valve.



7. Insert internal hex wrench into pressure-adjusting screw.

NOTE: Do not stroke pumps for more than 10 seconds at a time. Hydraulic oil will be passing over the relief valves and heating up rapidly.

8. Push attachment switch to FORWARD drive and adjust speed control knob until engine is lugged to approximately (2200 rpm). Observe pressure on both attachment gauges.

9. Adjust pressure relief setting by rotating pressure adjusting screw with internal hex wrench. Clockwise will increase pressure setting, counterclockwise will decrease pressure setting. Each complete rotation of adjusting screw changes pressure approximately 1350 psi (93 bar).

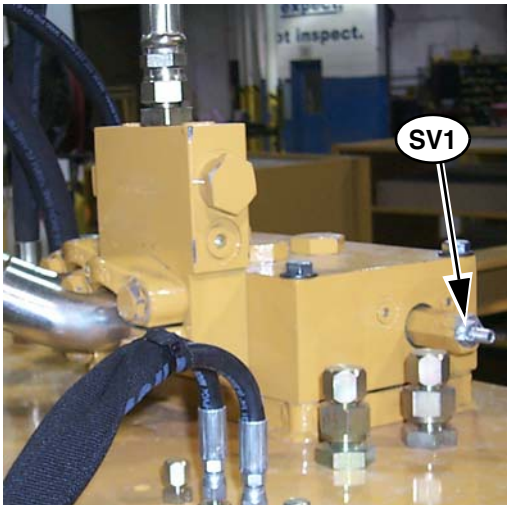
10. Adjust screw until pressure reaches 5000 psi (345 bar).

11. Return pump to its NEUTRAL position. The pressure in the high pressure circuit should return to charge pressure setting.

12. Hold pressure adjusting screw stationary, and tighten the pressure adjusting lock nut 26 in-lb (16 Nm).

Shuttle Valve - Adjust

13. With blocking plugs out, adjust shuttle valve screw SV1 as needed (turning the screw clockwise will increase pressure, counterclockwise will decrease pressure). Set charge pressure to 350 psi (24 bar) as indicated on charge pressure gauges with the attachment pressure gauge indicating between 2000–3000 psi (138–207 bar).



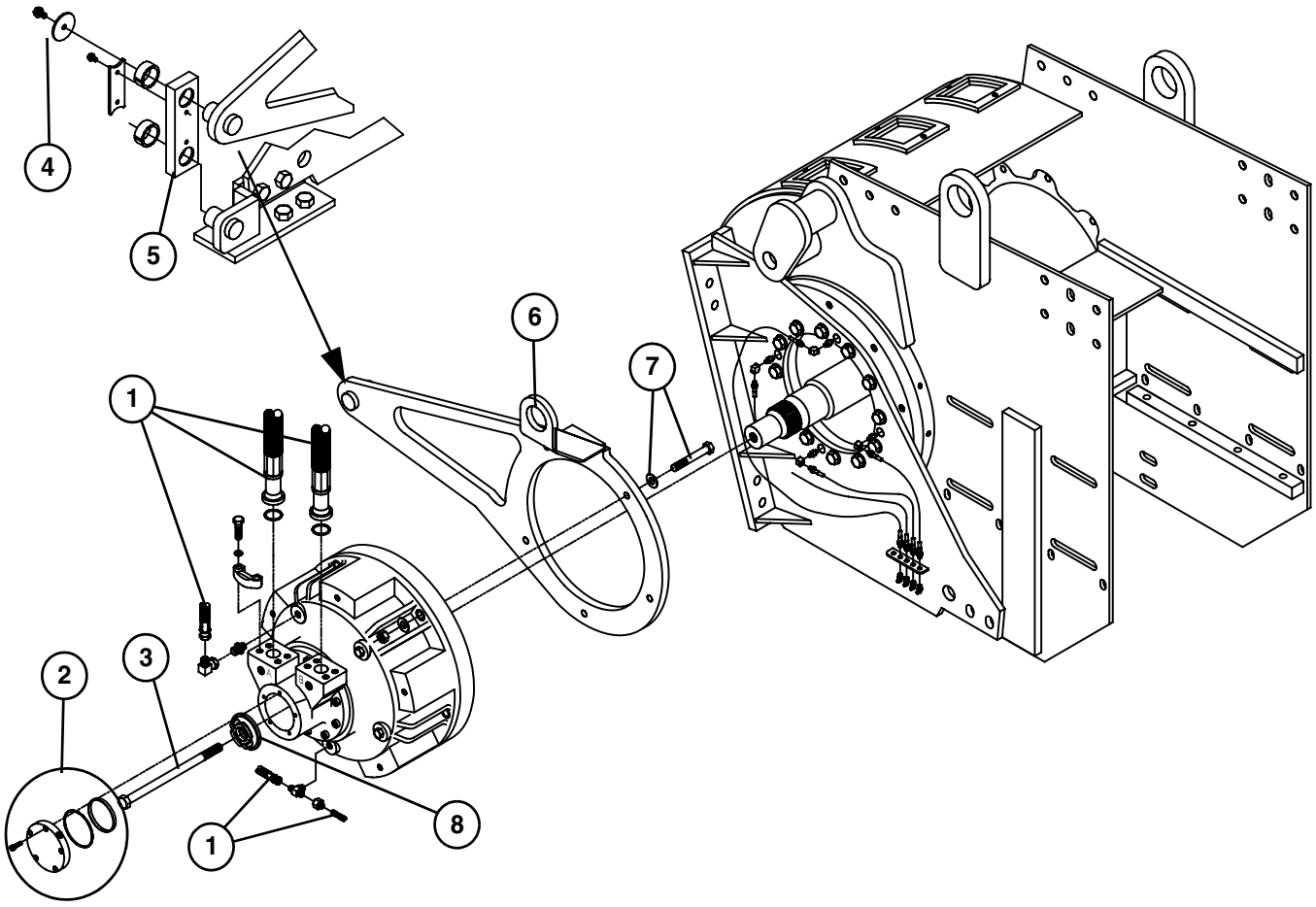
14. Once the correct pressure is set, decrease engine speed to IDLE. If the shuttle valve relief will not adjust correctly, it may be faulty. Refer to page **8C-9** for information repairing or replacing the valve.

15. Shut down engine.

16. Remove pressure gauges from manifold and install original plugs in their place.

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Trencher Drive Motor B5



Remove

To remove motor:

1. Follow *"Shutdown Procedure," page* **2C-1**.
2. Before working on the hydraulic system, release pressure in the oil tank by loosening filler cap
3. Refer to page **8C-1** and read general guidelines when servicing.
4. Label and disconnect each hose **(1)** from motor. Plug all hoses and ports; cap all fittings.
5. Remove end cap assembly **(2)**.
6. Remove locking collar **(8)**.
7. Cover opening to prevent dirt from entering.

Continued on next page...

8. Attach a suitable lifting device to lift loop on torque arm **(6)**.
9. Remove bolt **(3)**.
10. Remove torque arm pin mounting hardware **(4)** from bar **(5)**.
11. Remove motor and torque arm by sliding off spline of headshaft assembly. Lower to the floor.
12. Remove five bolts and washers **(7)** securing torque arm **(6)** to motor. Remove torque arm.

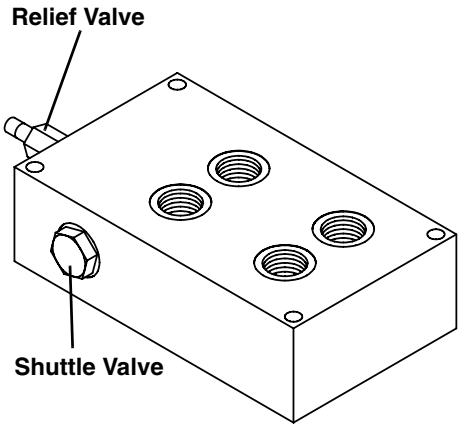
Install

1. Install torque arm to new motor using bolts and washers **(7)**. Torque bolts in cross-bolt pattern to standard torque.
2. Use a clean dry cloth to wipe the outside of headshaft clean of all dirt and debris.
3. Apply Molykote paste to headshaft splines.
4. Apply a thin film of oil to the outside of headshaft.
5. Remove end cap assembly **(2)** and lock collar **(8)** from new motor.
6. Using a suitable lifting device attached to torque arm lift loop, work the motor onto headshaft splines until fully seated.
7. Install and torque bolt **(3)** to 260–273 ft-lb (353–370 Nm).
8. Install locking collar **(8)** and torque bolts 30–33 ft-lb (41–45 Nm). Locking collar must be perfectly centered to assure no damage to the PPU.
9. Install cap assembly **(2)** and torque bolts 30–33 ft-lb (41–43 Nm).
10. Install torque arm mounting bar assembly **(4 & 5)** in reverse order as removed.
11. Remove hydraulic fittings from old motor if reusing, or install new fittings to new motor in same orientation.
12. Install all hoses to their original motor ports as labeled during removal.
13. Read and follow instructions in (Returning the System to Service) on **page 8C-2** before starting engine.

Manifold Valve Assembly

Remove

The shuttle and relief valve cartridges can be replaced as complete units or repaired with seal kits.



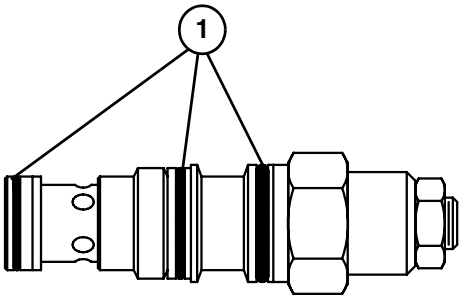
To remove a cartridge valve:

1. Follow *"Shutdown Procedure," page* **2C-1**.
2. Slowly loosen and remove cartridge valve. Inspect all the seals. If damaged, replace.

Seals - Replace

To replace seals:

1. Remove old seals **(1)**. Note orientation of the backup washers and O-rings. This will ensure the new seals will be installed correctly.



NOTE: The illustration is a generic representation of a cartridge valve. The valve seal replacement procedure is the same for all of the cartridge valves.

2. Install new seals in order old ones were removed.
3. Inspect manifold cavity for burrs or other irregularities which could damage O-rings during installation.
4. Dip cartridge in clean, filtered oil.
5. Screw cartridge in by hand until top O-ring is met.
6. Torque hex to 30–35 ft-lb (40–47 Nm).

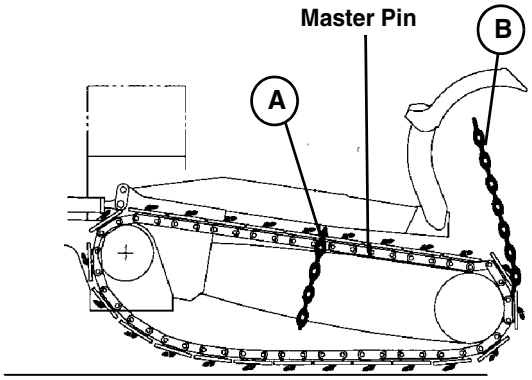
MECHANICAL REPAIR

Digging Chain

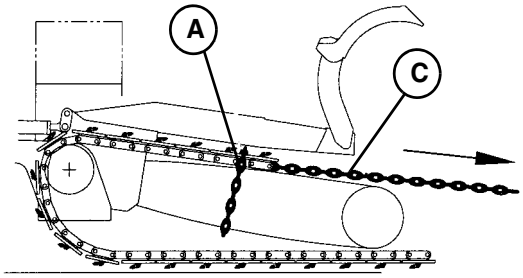
WARNING: Digging chain could unwind rapidly when the chain is unpinned. Serious injury could result if you are struck by the digging chain. Restrain the chain and clear the area when digging chain is unpinned.

Remove

1. Position master pin on top of boom, midway between drive sprocket and end idler. Lower boom just above ground. Shut off engine.
2. Fully retract boom.
3. Use a chain **(A)** with sufficient strength to restrain digging chain to boom between master pin and drive sprocket.



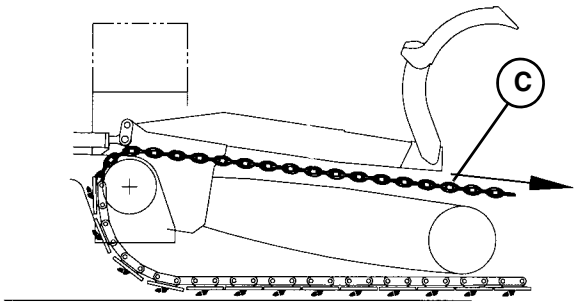
4. Attach a chain **(B)** with sufficient strength to the digging chain near top of end idler. Lift on chain **(B)** to relieve tension on master pin.



5. Drive master pin out.
6. **If shortening chain:** Remove chain links as necessary (grind off pin foot on same side as on master pin).
7. **If shortening chain:** Lift on chain **(B)** to align holes in chain links. Install master pin and adjust chain tension.
8. **If removing digging chain:** Lower free end of chain to ground. Attach a chain **(C)** to digging chain end on top of boom. Pull on chain **(C)** to remove tension from chain **(A)** and remove chain **(A)**.

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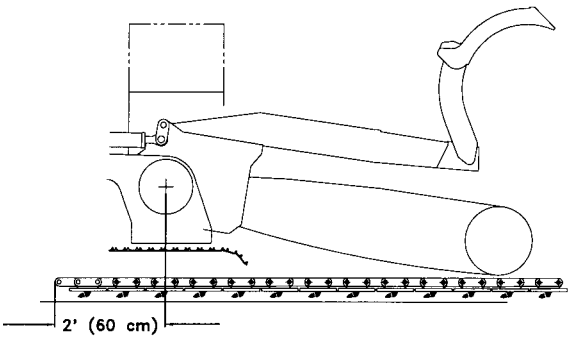
9. **If removing digging chain:** Slowly back up machine while running drive sprocket in reverse. Maintain enough tension on chain **(C)** to keep digging chain from unwinding rapidly. Lower digging chain to ground. Shut off engine.

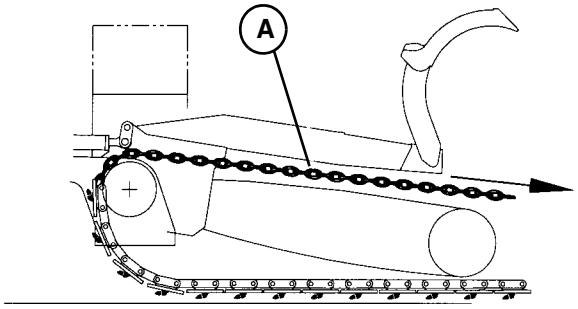


Install

WARNING: Digging chain is extremely heavy and could slide off the boom if not restrained. Serious injury could result if struck by the digging chain. Ensure everyone is clear of the digging chain area when working with the digging chain.

1. Fully retract boom. Lay chain flat, cutter side down.
2. Drive trencher to straddle chain so 2 ft (60 cm) of chain extends past drive sprocket.
3. Lower boom just above digging chain. Start engine.
4. Attach a chain **(A)** with sufficient strength to digging chain end which is under machine. Route chain over top of drive sprocket and out past end idler.

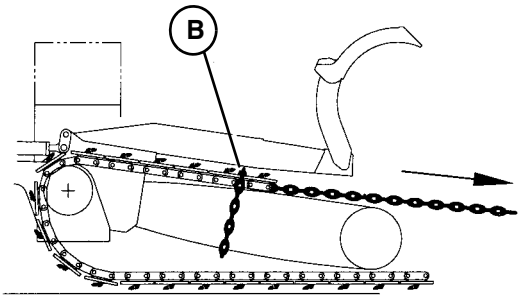




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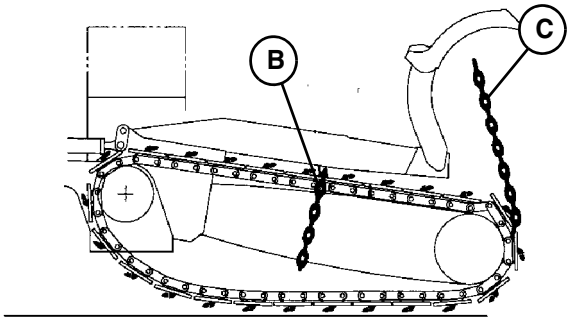
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5. Pull digging chain onto drive sprocket. Slowly run drive sprocket forward until end of digging chain is midway between drive sprocket and end idler. Shut off engine.



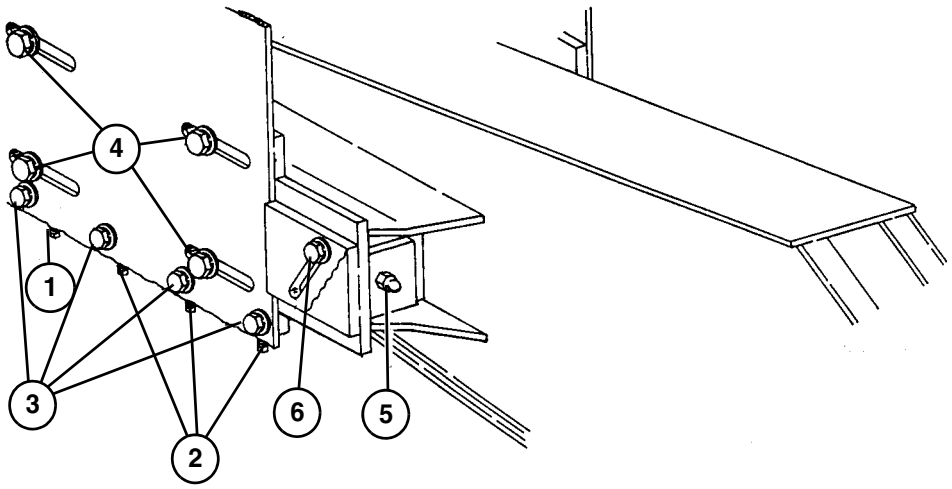
6. Use a chain **(B)** with sufficient strength to restrain digging chain to boom.

7. Pull free end of digging chain onto boom. Use a chain **(C)** with sufficient strength to align holes in chain links. Install master pin and adjust chain tension. See following page for instructions.



Digging Chain Tension

Adjust



40″ End Idler

Gap between chain and wear plate should be 1/2–1″ (1.3–2.5 cm) (boom horizontal, chain cooled from trenching).

Continued on next page...

20″ End Idler

Proper chain tensions are:
4 ft (1.2 m): 2–3″ (5–8 cm)
6 ft (1.8 m): 3–4″ (8–10 cm)
8 ft (2.4 m): 4–5″ (10–13 cm), single chain only

IMPORTANT: Always shut off engine after moving boom or running digging chain.

1. Follow *"Shutdown Procedure," page* **2C-1**.
2. Loosen four setscrews **(1 & 2))** on each side.
3. Loosen four 3/4″ bolts **(3)** on each side.
4. Loosen four 1″ bolts **(4)** on each side. If necessary, move bolts one at a time to alternate holes in boom for additional adjustment.
5. Loosen stop block bolts **(6)** on each side and add grease to fittings **(5)**. (To loosen chain, remove stop blocks and loosen ball check fittings until grease begins to be released.) Install both stop blocks at same setting.
6. Relieve pressure from grease cylinder by slowly unscrewing the ball check fitting until grease begins to be released from the cylinder.

NOTE: Weight of the digging chain may prevent the boom from extending further.

WARNING: Keep everyone away from moving digging chain. Contact with moving digging chain will result in death or serious injury.

7. Start engine and run chain until stop blocks are seated tightly. Follow *"Shutdown Procedure," page* **2C-1**.
8. Tighten stop block bolts and ball checks.
9. Tighten two inner setscrews **(1)**. Push boom down (raise tracks slightly). Tighten six setscrews **(2)**. Tighten eight 3/4″ bolts **(3)** to 300 ft-lb (405 Nm). Tighten eight 1″ bolts **(4)** to 920 ft-lb (1,250 Nm).
10. Adjust trench cleaner.

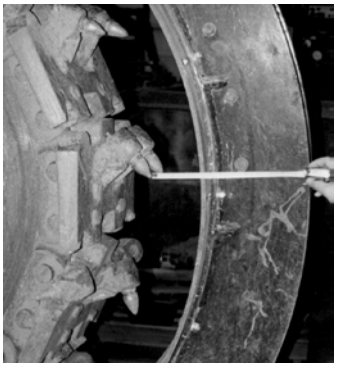
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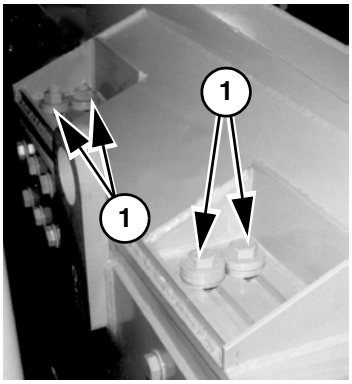
Trench Cleaner

Adjust

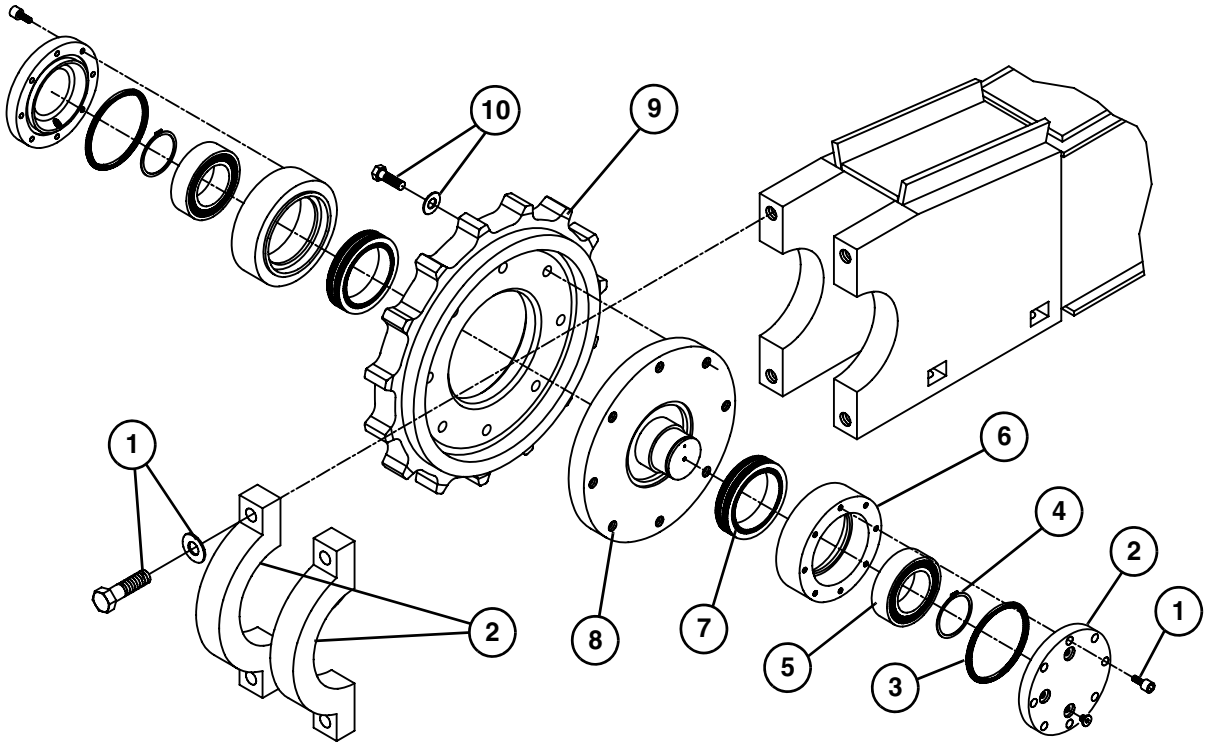
Trench Cleaner Bridge: 1 1/2 –2″ (4–5 cm)

1. Support bridge and loosen bolts **(1)** on both sides.
2. Adjust bridge to provide 1-1/2–2″ (4–5 cm) of clearance between trench cleaner shoe and cutter tips.
3. Tighten bolts and recheck clearance.





End Idler Assembly



Remove

The illustration above shows a single chain end idler. The assembly for a double-chain end idler is the same, though the hub is wider. To remove end idler assembly when replacing bearings:

1. Follow *"Shutdown Procedure," page* **2C-1**.
2. Remove digging chain assembly. Refer to T655III *Maintenance Manual* for complete instructions.
3. Using a suitable lifting device, support the end idler assembly.
4. Remove four 1″ bolts and washers **(1)**. Remove clamps **(2)**. Remove end idler assembly from boom.

Perform the following steps on both sides of the hub **(8)**.

5. Remove eight screws **(1)** securing bearing cap **(2)**. Remove the cap and O-ring **(3)**. This will release most of the oil in the assembly.
6. Remove the snap ring **(4)** and pull the bearing mount **(6)** and bearing **(5)** off the idler shaft using a bearing pulling tool.
7. Remove seal **(7)**.
8. Inspect all parts and replace any that are worn or damaged.

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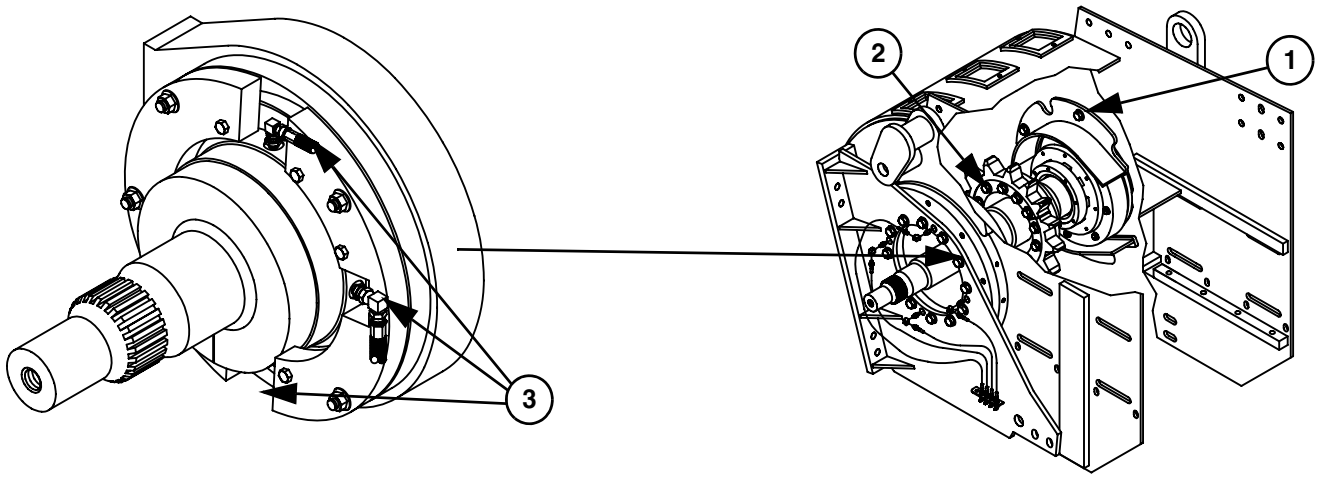
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Install

Install the components in the reverse order they were removed. Ensure the following is done when installing:

- Use isopropyl alcohol to de-grease all surfaces that will contact the new seals and O-rings. Allow all alcohol to evaporate before installing any seals or O-rings.
- Lubricate new O-rings with film of oil as you install them. Use the same oil used to fill the rebuilt idler. Refer to *"Fluid and Lubricants," page* **2C-7** for oil specifications.
- Use a lint free cloth to wipe the metal surfaces that mate to the seals. These areas must be undamaged, clean and lint-free.
- Use care not to contaminate new seals when installing.
- Use a hydraulic press to press the bearings and mount onto the shaft.
- With boom level, fill bearing mounts with oil. Refer to *"Fluid and Lubricants," page* **2C-7** for oil specifications.

Headshaft Assembly

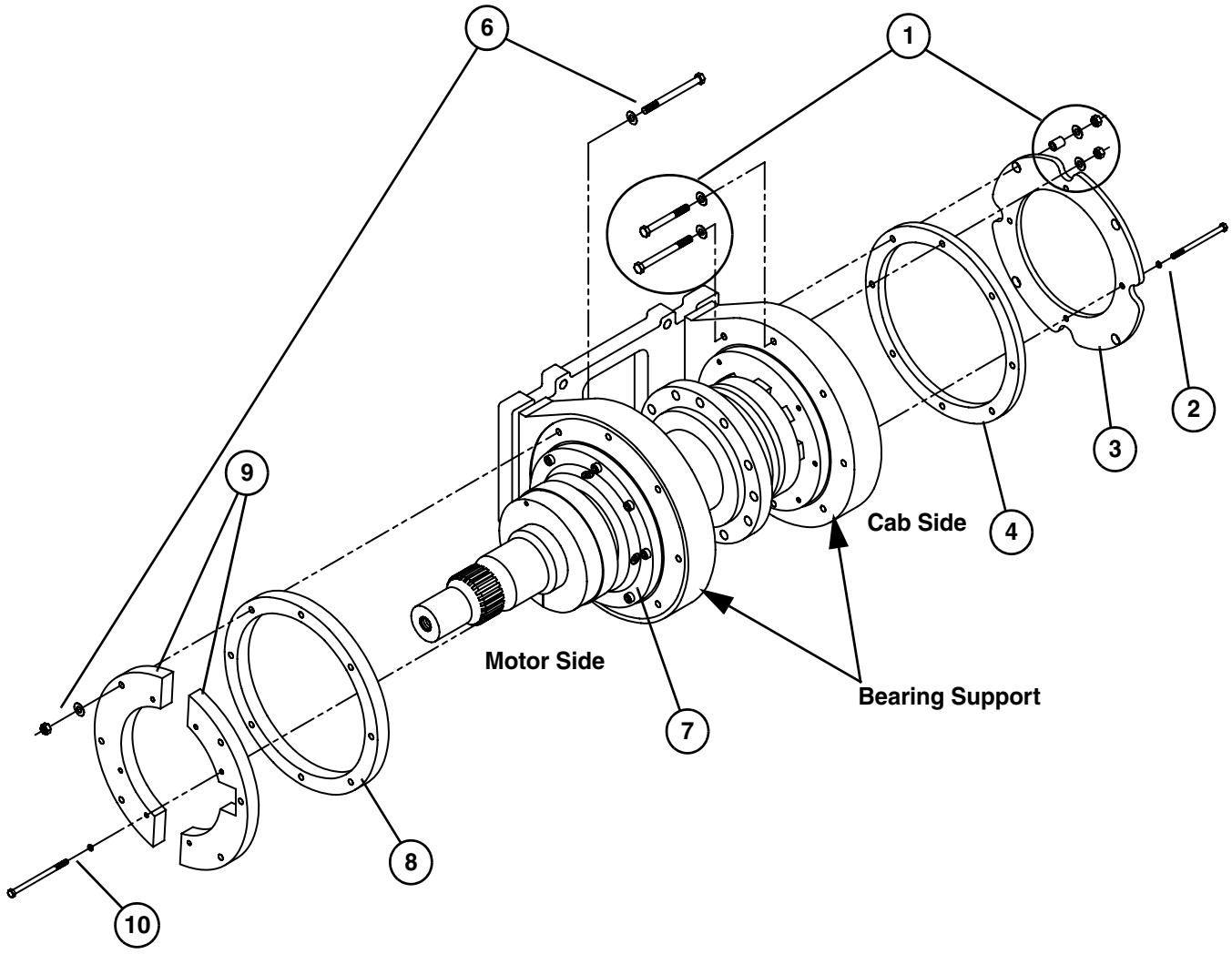


Remove

To remove headshaft assembly when replacing bearings:

1. Follow *"Shutdown Procedure," page* **2C-1**.
2. Remove digging chain assembly. Refer to page **8C-10** for instructions.
3. Remove trencher drive motor. Refer to page **8C-7** for instructions.
4. Remove headshaft shields **(1)** by removing eight bolts and washers securing them to both sides of boomhead.
5. Mark sprocket halves and hubs to aid in reassembly. Each half must be installed with its correct mate, and each hole in the sprocket must align with its original holes in hub. Remove sprocket halves by removing bolts, washers, and nuts **(2)** securing them to headshaft.
6. Remove and cap headshaft bearing oil lines and fittings **(3)** from both sides of headshaft assembly. Drain oil from bearings.

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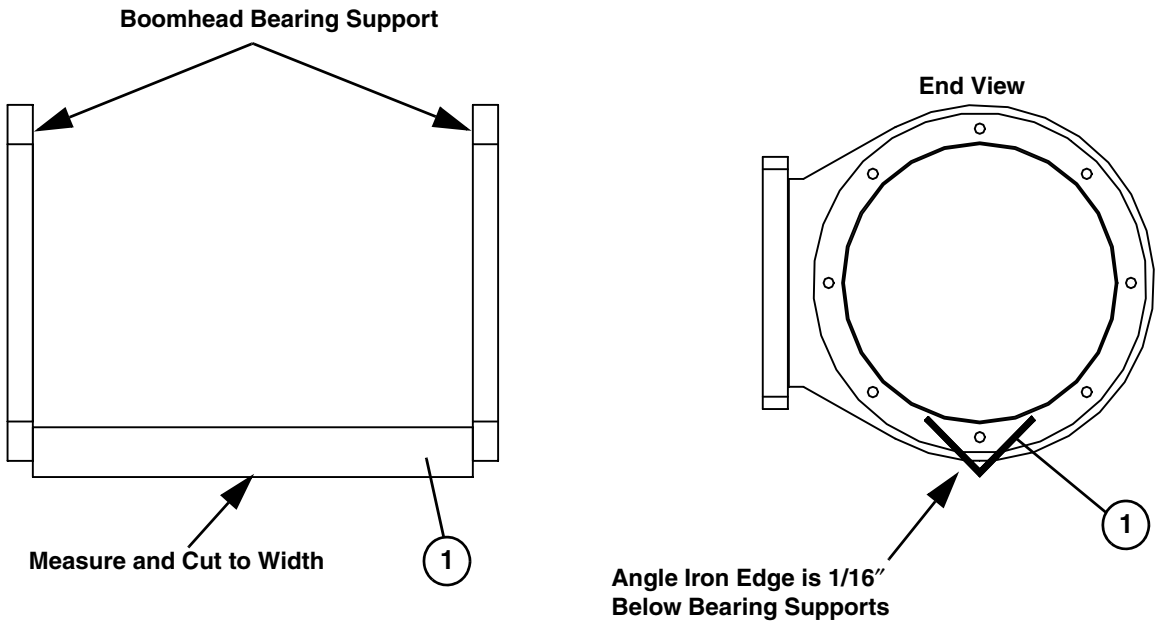
Cab side of headshaft assembly:

7. Remove 1/2″ bolts, washers, and bushings **(1)** from bearing stop **(2)**, shield pivot ring **(4),** and bearing support.
8. Remove 3/8″ bolts, washers, **(2)** from bearing stop **(3)** and bearing retainer (not shown). Remove bearing stop **(3)** and shield pivot ring **(4)**.

Trencher motor side of headshaft assembly:

9. Remove 1/2″ bolts, washers, and nuts **(6)** from bearing support, retainer **(9)**, and spacer **(8)**.
10. Remove 3/8″ bolts and washers **(10)** from retainer **(9)**, seal retainer mount **(7)**.

Continued on next page...



NOTE: Welding a 1/4 x 4″ piece of angle iron **(1)** between boomhead bearing supports will aid in the removal of the headshaft assembly. The headshaft will slide on this angle iron during removal.

11. Cut angle width to fit inside boomhead bearing support. Weld angle iron as shown with open end of angle approximately 1/16″ below edge of boomhead bearing support.

12. Using a suitable lifting device and a nylon lifting sling on spline end, move bearings and shaft as an assembly out of the trencher motor side of machine.

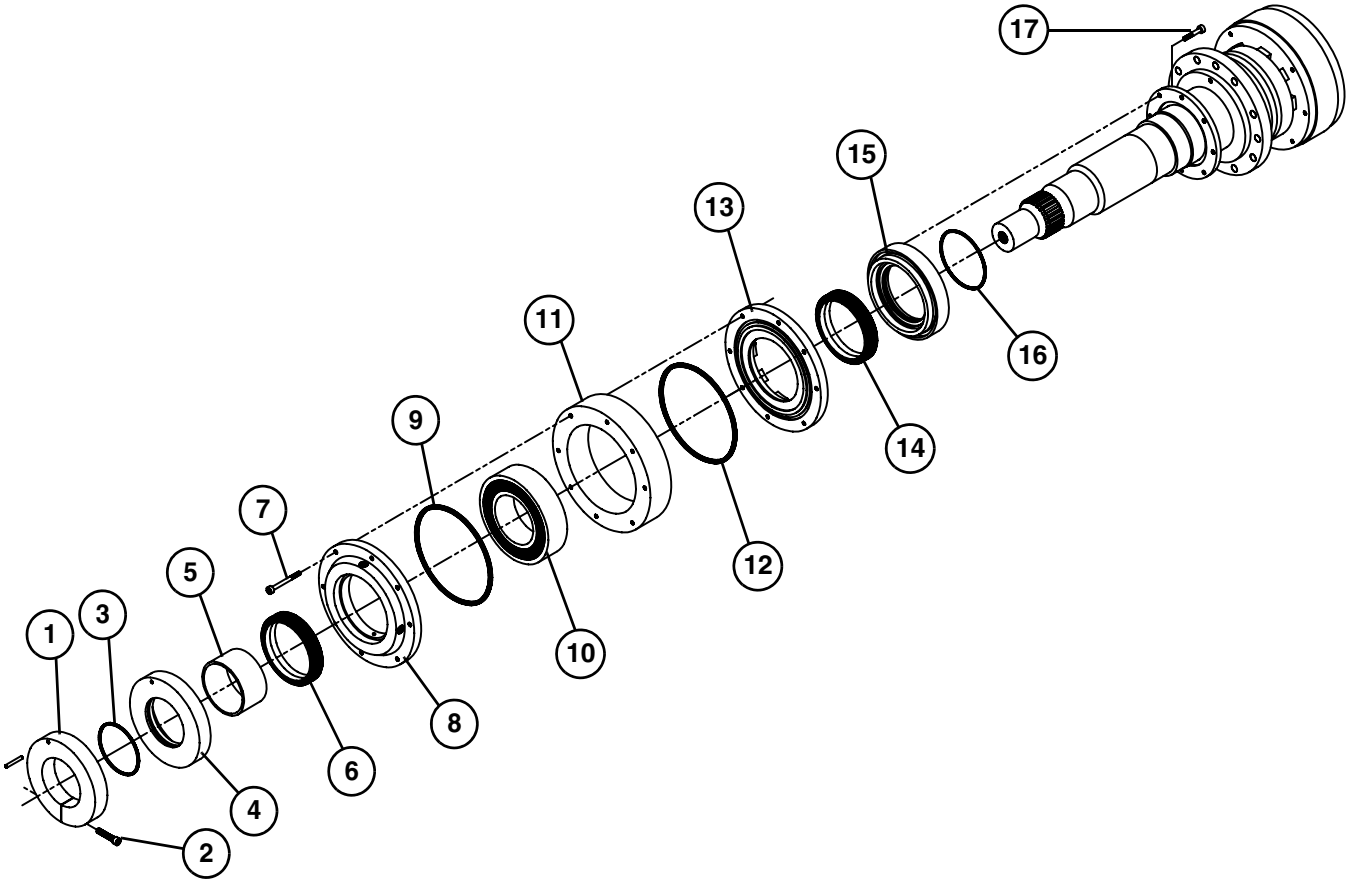
13. Add a second nylon sling to center of headshaft when cab end of bearing and shaft assembly is at the bearing support on trencher motor side.

14. Finish sliding shaft and bearing assemblies out of supports and lower to floor or workbench.

Leave welded angle iron in place to assist with reinstalling the shaft and bearing assemblies. Remove angle when headshaft is completely installed.

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Headshaft Bearings



Remove

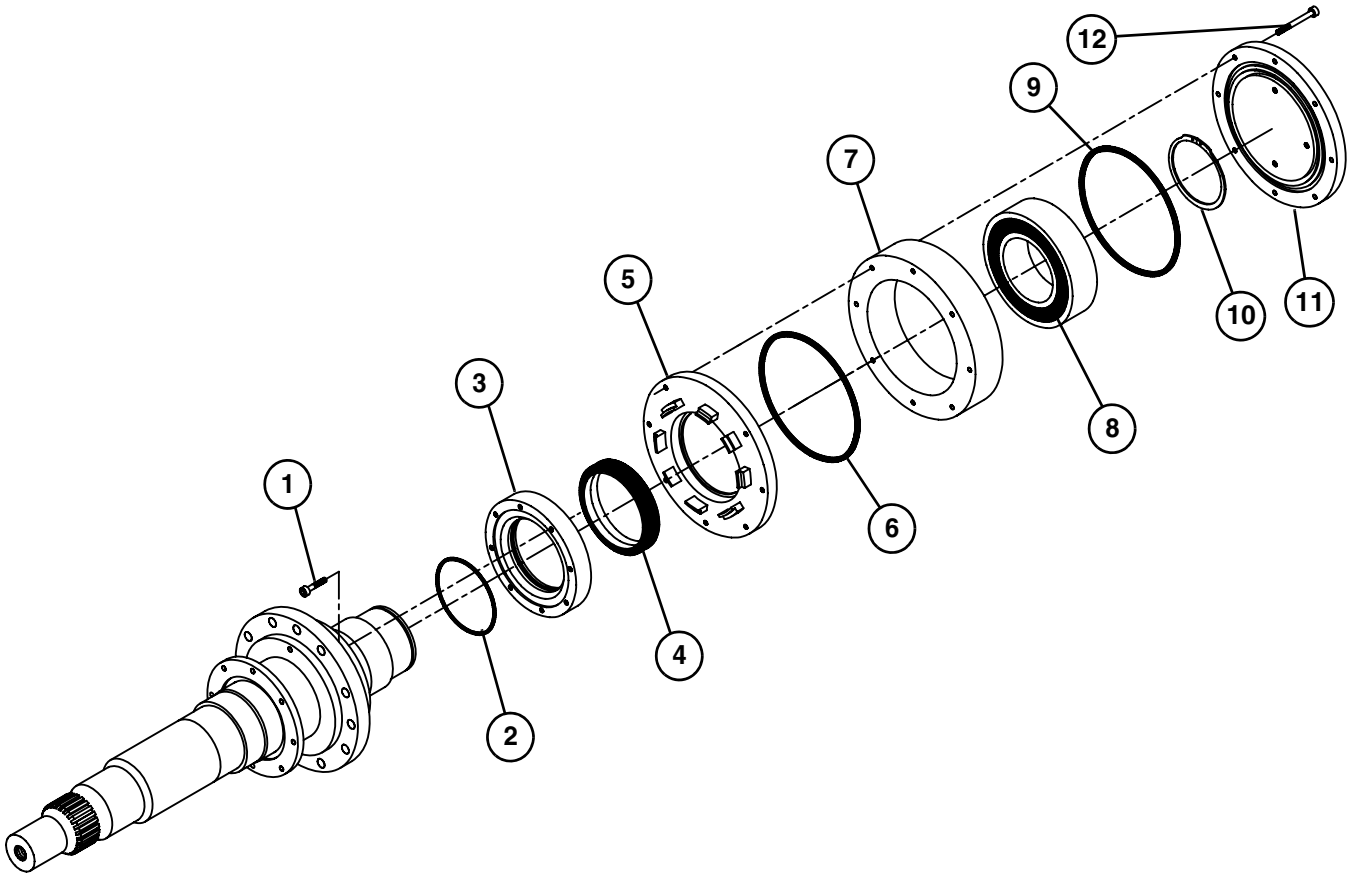
NOTE: The bearings must be split (destroyed) anytime a bearing, inner seal or O-ring needs to be replaced. If replacing a bearing, you should always replace seals and O-rings with new ones.

To remove bearings from trencher motor side:

1. Remove 1/2″ screw **(2)** securing collar in place. Remove collar.
2. Remove O-ring **(3)**.
3. Remove seal retainer **(4)** and spacer **(5)**.
4. Remove Duo-Cone seal **(6)**.
5. Remove 3/8″ bolts **(7)** securing seal retainer mount **(8)** to bearing mount **(11)**.
6. Remove seal retainer mount **(8)** and bearing mount **(11)**.
7. Remove O-ring **(12)**.

Continued on next page...

8. Use a pneumatic die grinder with a cut-off disk to cut the outer race off bearing. Cut cage to remove the rollers. Be careful to avoid nicking or damaging the headshaft. Cut through and remove inner race of bearing.
9. Remove bearing **(10)**.
10. Remove bearing retainer **(13)**.
11. Remove Duo-Cone seal **(14)**.
12. Remove O-ring **(16)**.



To remove bearings from cab side of headshaft assembly:

1. Remove 3/8″ bolts **(12)** securing bearing cap **(11)**. remove bearing cap.
2. Remove O-ring **(9)**.
3. Remove snap ring **(10)**.
4. Remove bearing mount ring **(7)**.
5. Remove O-ring **(6)**.

Continued on next page...

6. Use a pneumatic die grinder with a cut-off disk to cut the outer race off bearing. Cut cage to remove the rollers. Be careful to avoid nicking or damaging the headshaft. Cut through and remove inner race of bearing.
7. Remove bearing **(8)**.
8. Remove bearing retainer **(5)**.
9. Remove Duo-Cone seal **(4)**.
10. Remove O-ring **(2)**.

Install

NOTE: The new bearings are heated in oil to expand them, then quickly placed on the shaft where they cool and contract to an interference fit. Since the shaft will draw heat from the bearing rapidly, it is important the technician doing the work thoroughly understands the procedure and has all the parts and tools at hand before attempting to install the bearing.

Install the components in the reverse order they were removed. Ensure the following is done when installing:

- Use isopropyl alcohol to degrease all surfaces that will contact the new seals and O-rings. allow all alcohol to evaporate before installing any seals or O-rings.
- Apply a light coat of oil around all O-rings.
- Apply thread lock sealant to all bolts/screws.
- Apply anti-seize to inside diameter of bearing supports.
- Seal packages include a lint-free cloth. Use it to wipe the metal surfaces that mate to seals. These areas must be undamaged, clean and lint-free.
- Use care not to contaminate new seals when installing.

Heating Bearings

Bearings can be heated using two different methods:

- Induction Heater
- Hot Oil

WARNING: Hot oil splashed onto exposed skin or clothing can cause serious burns. Wear face shield and protective clothing when working with hot oil. Never reach into hot oil with gloves on. Use a tool to lift bearings from hot oil.

Continued on next page...

Both methods require heating the bearings to 275°F ± 5° (135°C ± 2°). When using the hot oil method, suspend the new bearing in the heating container. Do not allow the bearing surface to touch the bottom or sides of the pan. Cover the bearing with hydraulic oil and heat the pan to 275°F ± 5° (135°C ± 2°). Use a thermometer to monitor the temperature.

NOTE: If the oil is too cool, the bearing will not expand sufficiently. If bearing becomes too hot, it can be damaged. When heated, use a tool to pull bearing out of hot oil. Wear clean leather welding gloves to handle the hot bearing.

IMPORTANT: The heated bearing will cool rapidly, slide bearing onto shaft and ensure bearing is placed fully against the land.

After headshaft components are installed, refer to page **8C-17** and install headshaft assembly to boomhead. Refer to page **8C-7** and install trencher drive motor and torque arm assembly. Refer to page **8C-10** and install digging chain.

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Chapter 9—Cross Conveyor Subsystem

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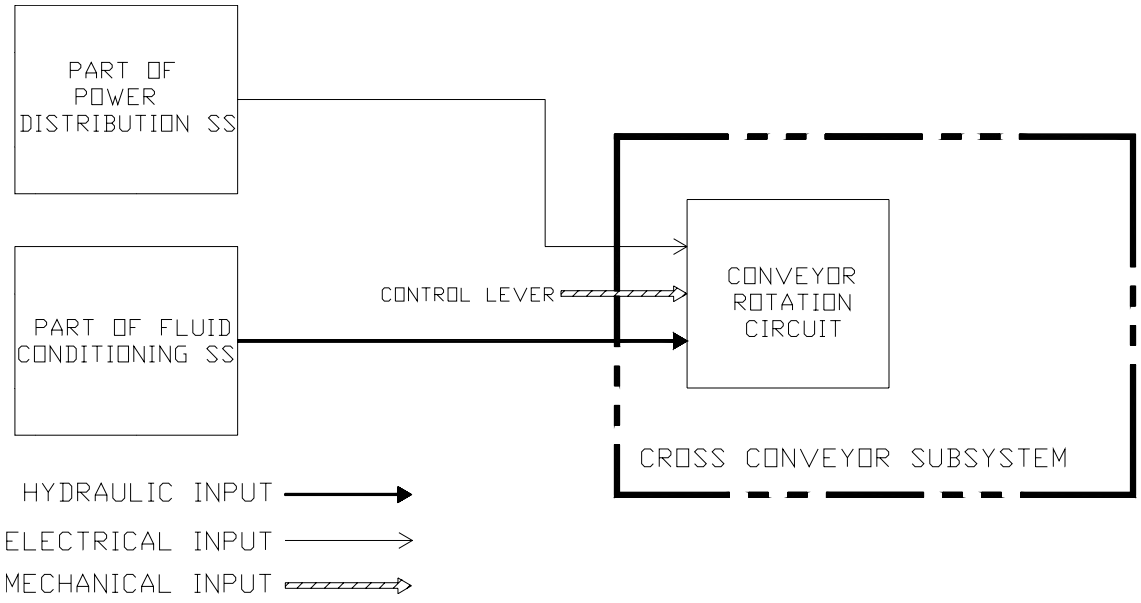
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Chapter 9: Cross Conveyor Subsystem

Section A: Theory

OVERVIEW



Lines and arrows on the MAP illustrate the interdependencies of the subsystems. The Power Distribution and Fluid Conditioning subsystems supply the electrical and hydraulic input and a lever controls the mechanical input necessary for operation.

The Cross Conveyor subsystem consists of the circuits and components necessary for controlling conveyor rotation, speed, and trench spoil discharge. The optional conveyor shift function is considered part of the Implement subsystem because its function is controlled by the Implement subsystem hydraulic control valve and pump. For information on conveyor shift functions, refer to “Conveyor Shift Circuit (Optional),” page 6A-25.

NOTE: There are two cross conveyor versions. One version is a flat version using one hydraulic motor for rotation. The other version is a curved version that uses two hydraulic motors for rotation.

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Circuits/Components

The following circuits and components are part of the Cross Conveyor subsystem.

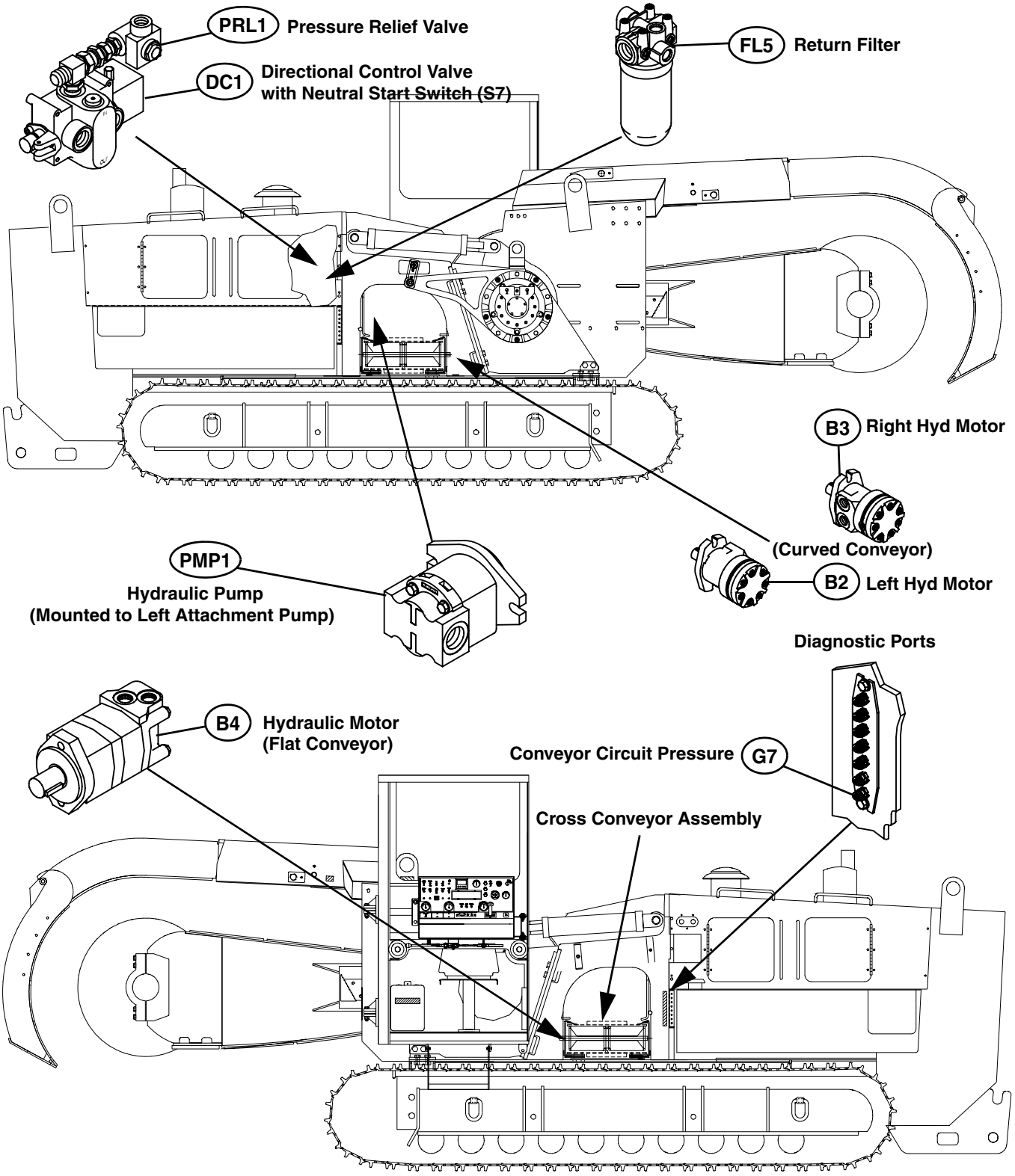
Flat Conveyor Rotation Circuit:

Fluid Conditioning Components
Hydraulic Pump PMP1
Hydraulic Motor B4
Directional Control Valve DC1
Relief Valve PRL1
Return Filter FL5
Conveyor Circuit Pressure Diagnostic Port G7

Curved Conveyor Rotation Circuit:

Fluid Conditioning Components
Hydraulic Pump PMP1
Left and Right Hydraulic Motors B2 & B3
Directional Control Valve DC1
Relief Valve PRL1
Return Filter FL5
Conveyor Circuit Pressure Diagnostic Port G7

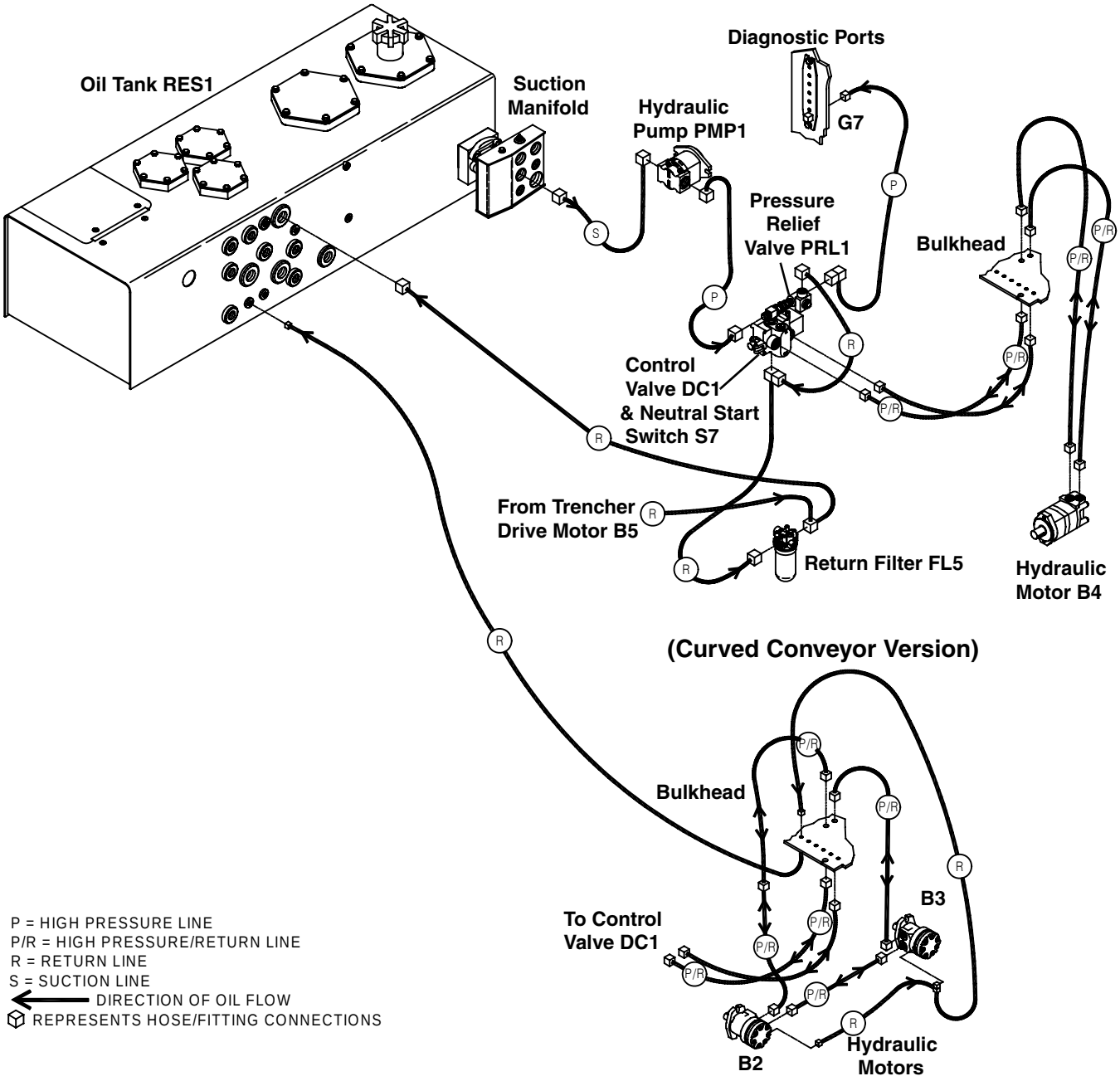
Component Locations



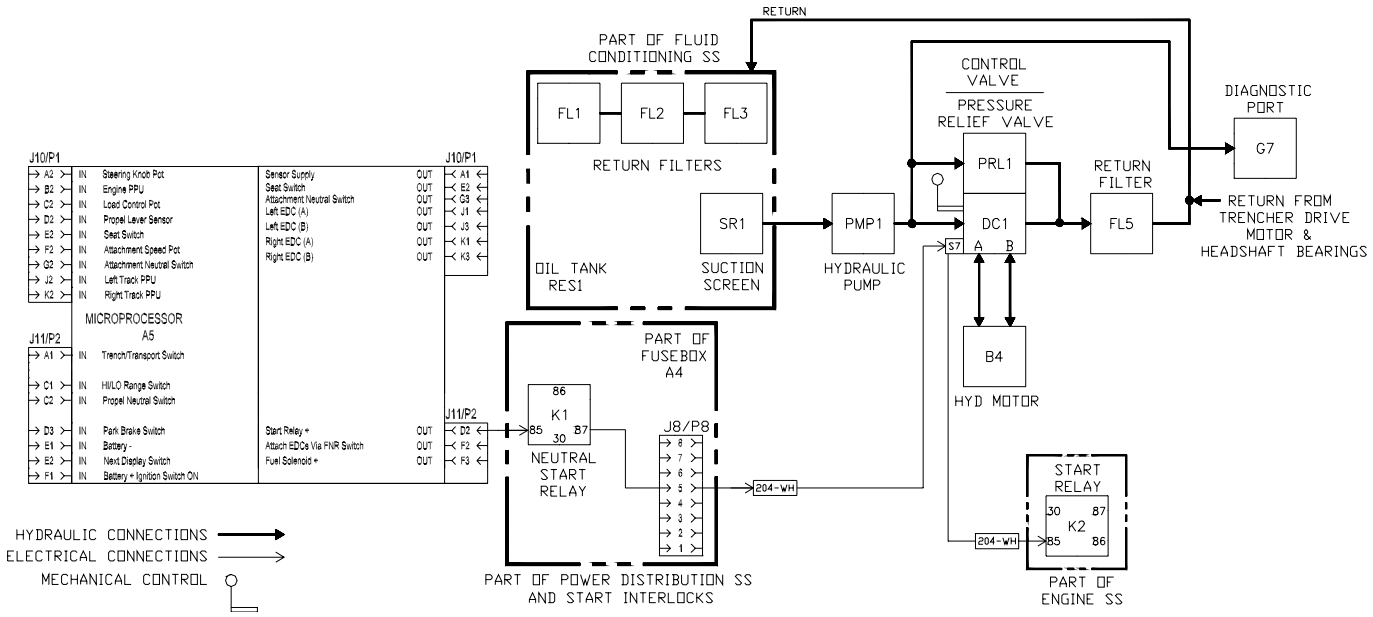
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Hydraulic Hose Connections

Note: Orientation of components does not reflect actual machine configuration.



FLAT CONVEYOR ROTATION CIRCUIT



Operation

The flat cross conveyor rotation circuit is controlled manually from a control lever installed in the operator station/cab. The lever controls both speed and direction of the conveyor. Trenching spoil is discharged alongside of machine during operation. The spoil can be discharged from either side of machine depending on the position of control lever.

The conveyor control valve DC1 utilizes a neutral start switch S7 located in the control valve switch block assembly installed on the valve. The switch works off of a detent spool and is closed when conveyor lever is in NEUTRAL. This completes the circuit from the neutral start relay A4K1 to engine start relay K2.

The switch is part of the machine's START interlock system. The conveyor control lever must be in the NEUTRAL position before engine will start. Refer to "Engine Start Interlocks," page **2-13** for detailed interlock operating information.

When conveyor control lever is in NEUTRAL, hydraulic flow from pump PMP1 flows through control valve DC1 and is used to flush the trencher drive motor case and boom headshaft bearings.

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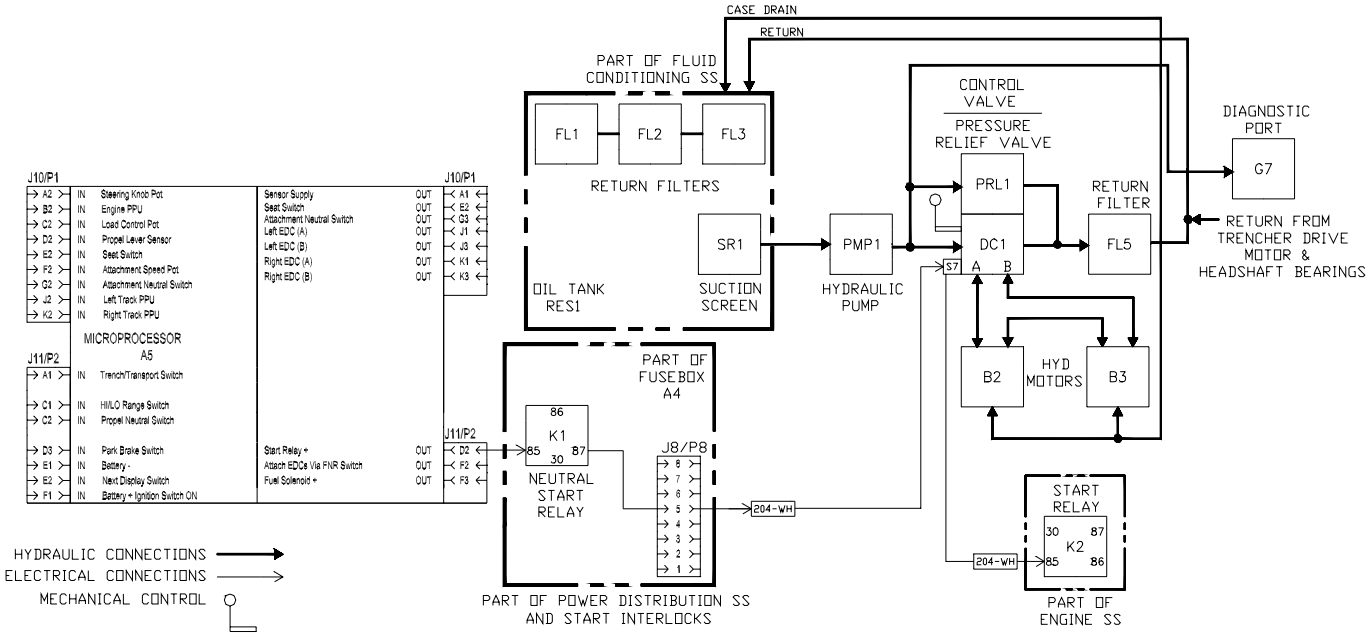
Spoil Discharge

When conveyor control lever is pushed from NEUTRAL, control valve DC1 spool will shift. Hydraulic oil flow from the uni-directional pump PMP1 is directed to the bi-directional rotation motor B4, turning it clockwise. The spoil will be discharged on right side of machine. When the lever is pulled back, the spool shifts to opposite position. The motor will reverse to discharge spoil on left side of machine.

The pressure relief valve PRL1 is set at 2500 psi (172 bar) to control maximum system pressure. Pressure spikes above 2500 psi (172 bar) will cause the relief valve to open. Oil flow will be directed through a return filter FL5 and back to tank. During normal operation the return flow is directed through filter FL5, where it is filtered and returned back to the tank to be recycled.

The diagnostic port G7 allows a pressure gauge to be installed for checking conveyor rotation circuit pressure.

CURVED CONVEYOR ROTATION CIRCUIT



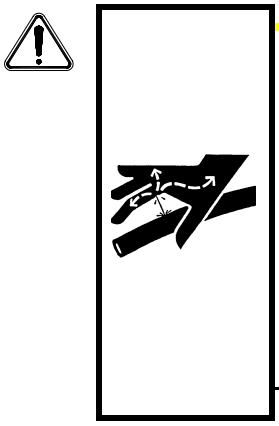
Operation

The curved conveyor rotation circuit works the same way as the flat conveyor circuit only the curved conveyor uses two rotation motors B2 & B3. The rotation motors are also externally drained.

Chapter 9: Cross Conveyor Subsystem

Section B: Troubleshooting

OVERVIEW



WARNING: Pressurized fluid can penetrate body tissue and result in serious injury or death. Leaks can be invisible. Keep away from any suspected leak. Relieve pressure in the hydraulic system before searching for leaks, disconnecting hoses, or performing any other work on the system. If you must pressurize the system to find a suspected leak, use an object such as a piece of wood or cardboard rather than your hands. When loosening a fitting where some residual pressure may exist, slowly loosen the fitting until oil begins to leak. Wait for leaking to stop before disconnecting the fitting. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

Pretest Inspection

Before beginning any troubleshooting, review information in the General Information Chapter under “Troubleshooting Guidelines,” page **1-9**.

If a malfunction occurs, do the following visual checks to inspect for obvious signs of failures before any testing is performed.

- Check for any obvious mechanical failures such as, broken linkages, cables, sprockets, chains, sheaves, pulleys, belts, and so on.
- Check hydraulic oil level in tank, especially if other subsystem/circuits are experiencing similar performance problems.
- Check hydraulic circuits for any obvious failures such as, broken, kinked, loose, or leaking motor or pump shaft seals, leaking hoses and fittings on supply, pressure, and return to hydraulic components. Also, check for broken, missing, corroded, or loose connections and wires that supply ground and power to electrical components.

Fault Chart

If no problems were found during the pretest inspection, refer to the fault chart on page **9B-3** and continue troubleshooting. The possible malfunctions listed do not cover everything that could go wrong with the circuits. They are meant to give a technician a logical place to begin, based on performance observations.

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Test Equipment Needed

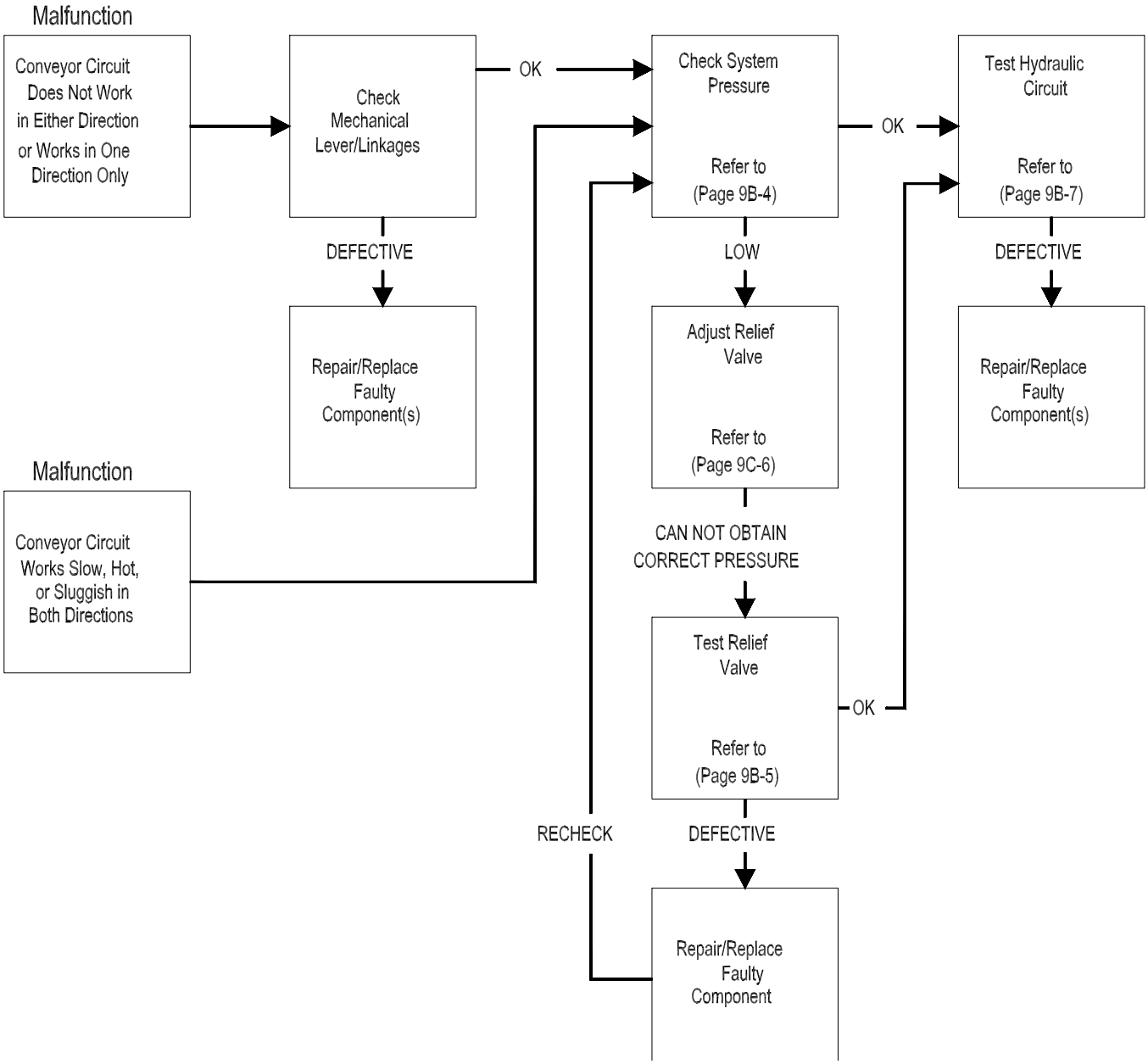
IMPORTANT: The pressure and flow ratings of the test equipment used to conduct the following hydraulic test procedures must be equal to, or greater than the pressure and flow ratings of the circuit being tested.

- Pressure Gauges
- Needle Valve
- Flow Meters
- Vacuum Gauge
- Phototachometer
- Pyrometer
- Digital Multimeter

Component Repair/Replace

If troubleshooting procedures determine a component is in need of repair or replacement, refer to section C for the appropriate repair procedures for those components.

FAULT CHART


Malfunction
Conveyor Circuit Does Not Work in Either Direction or Works in One Direction Only
Check Mechanical Lever/Linkages
OK
Check System Pressure
Refer to (Page 9B-4)
OK
Test Hydraulic Circuit
Refer to (Page 9B-7)
DEFECTIVE
Repair/Replace Faulty Component(s)
LOW
Adjust Relief Valve
Refer to (Page 9C-6)
DEFECTIVE
Repair/Replace Faulty Component(s)
Malfunction
Conveyor Circuit Works Slow, Hot, or Sluggish in Both Directions
CAN NOT OBTAIN CORRECT PRESSURE
Test Relief Valve
Refer to (Page 9B-5)
OK
RECHECK
DEFECTIVE
Repair/Replace Faulty Component

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CONVEYOR ROTATION CIRCUIT

Hydraulic Troubleshooting

The pressure in the hydraulic system should be checked to quickly determine how to begin to accurately troubleshoot the system. A diagnostic fitting located on the side of the machine is provided to check cross conveyor drive pressure.

Snubbers are recommended to protect the pressure gauge. Gauge calibration is necessary to ensure accurate readings. If system pressure is correct, refer to page 9B-7 and test the hydraulic circuit for excessive leakage.

System Pressure - Check

To check the cross conveyor system pressure:

1. Install pressure gauge capable of at least 3000 psi (207 bar) in the conveyor pump system pressure diagnostic gauge port located on the side of machine.
2. Remove hoses from conveyor drive motor(s). Cap fittings and plug hoses.
3. Start the engine and set engine speed to full throttle.
4. Ensure hydraulic oil is warmed to at least 100°F (38°C).
5. Move conveyor lever either direction out of NEUTRAL and observe gauge.

   Expected result: The pressure gauge should read approximately 2500 psi (172 bar). If pressure is not within specification, try adjusting the valve. Refer to page 9C-6 of the repair section for adjustment procedure.

6. After adjustment, check relief pressure for proper setting as described above. If correct pressure can not be obtained, test relief valve. See following page.

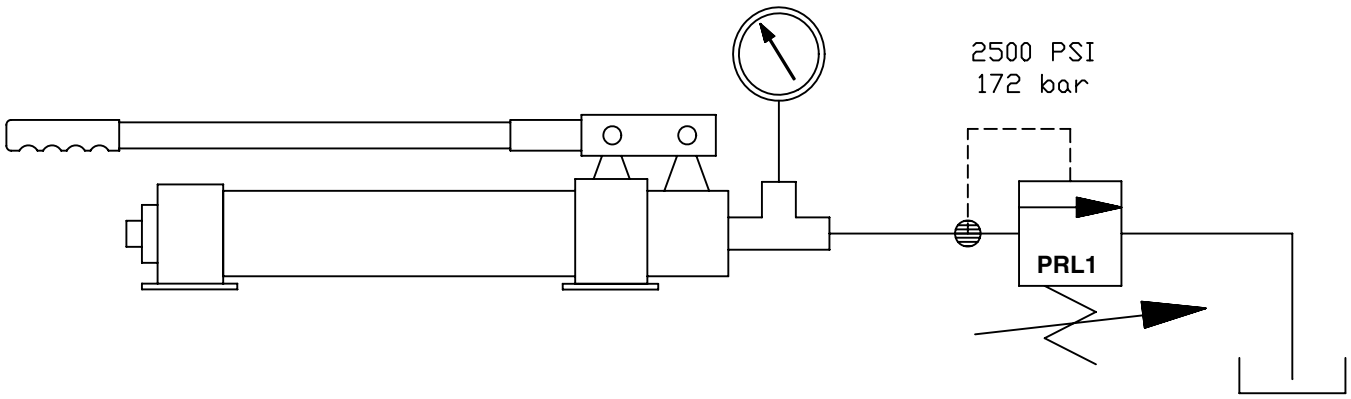
Pressure Relief Valve PRL1 Test Procedure

Excessive noise associated with hydraulic systems may come from a relief valve that is faulty or set incorrectly. A noisy relief valve will have a steady high-pitched screeching noise.

The constant opening and closing of the poppet can lead to poppet seat deterioration. Seat deterioration could result in cross-port leakage. Cross-port leakage can also be caused by fine particles of contamination, in high velocity stream of oil, striking the poppet seat. This could eventually lead to seat erosion.

The most common symptoms associated with excessive relief valve leakage are:

- Motors fail to respond when the directional control valve is actuated.
- A loss of motor speed which is viscosity sensitive. As the fluid temperature increases, actuator speed progressively decreases.
- Moderate to high increase in the operating temperature of the fluid.
- Motors slow as the load (pressure) increases.



1. Release any residual pressure, then remove relief valve from the system for test procedure.
2. Disconnect the line from relief valve inlet and connect a porta-power in series with the inlet of the relief valve.
3. Install pressure gauge in parallel with the connector at the outlet port of porta-power.
4. Gradually pressurize the inlet port of relief valve. Stop and maintain pressure when the value of the relief valve setting, 2500 psi (172 bar), is reached.

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5. Observe leakage relative to the rate at which the pressure, indicated on pressure gauge decreases.
6. Open pressure release valve on the porta-power. Release pressure between porta-power and relief valve.

Analyzing Test Results

Diagnostic Observation 1:

- Relief valve shows no sign of cross-port leakage until cracking pressure is reached, slightly below 2500 psi (172 bar).

Diagnosis - The relief valve is in satisfactory condition. Test the rest of the hydraulic circuit. See page 9B-7.

Diagnostic Observation 2:

- The pressure attempts to increase as the porta-power is actuated but rapidly declines. A steady stream of fluid flows from the outlet port of the valve, well below the pressure setting of the valve (below normal cracking pressure).

Diagnosis - There is evidence of cross-port leakage which could be caused by internal damage, wear, and/or, contamination between the spool and seat assembly. Replace or repair valve.

Diagnostic Observation 3:

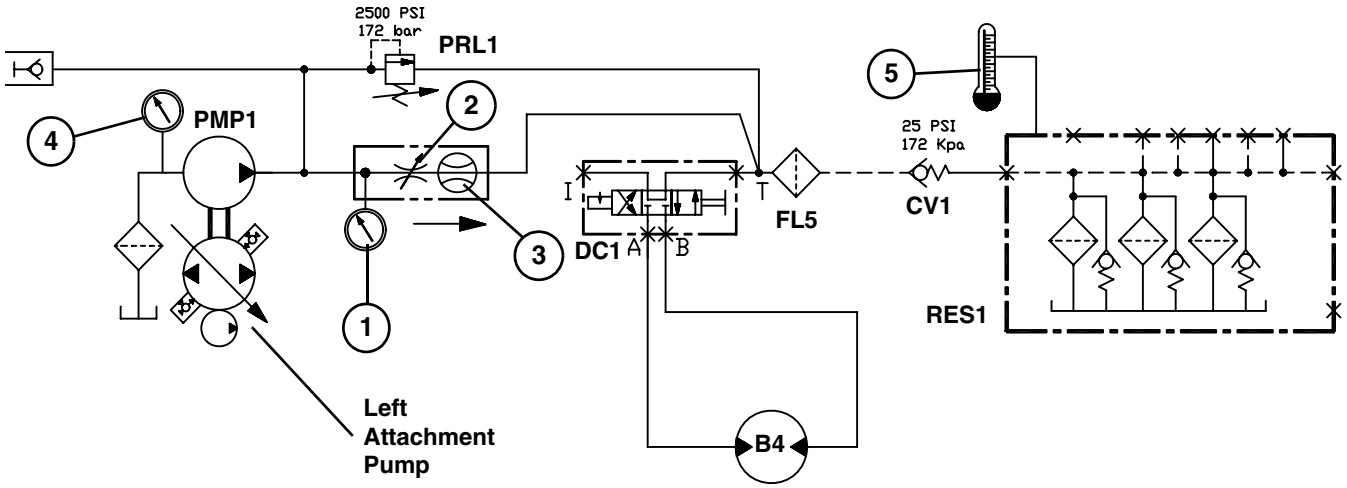
- The porta-power fails to pressurize the inlet port of the valve while a steady stream of oil pours from the outlet port. Profuse cross-port leakage which occurs well below the setting of valve (below normal cracking pressure).

Diagnosis - There is evidence of valve failure which could be caused by internal damage, wear, and/or, contamination between the spool and seat assembly. Replace or repair valve.

Hydraulic Circuit Test Procedures

The hydraulic circuit test procedure takes a logical approach based on component location and the degree of difficulty of testing components in the circuit. The following procedures begin with testing the pump. The test procedure will determine the amount of leakage across the ports of the pump. The control valve and motor(s) will be isolated from the hydraulic circuit during this test.

Pump PMP1 - Test



IMPORTANT: Ensure any hoses or fittings that are added to the test equipment are the same size and rating as hoses and fittings installed in the hydraulic circuit. Mismatched hose or fitting sizes can result in erroneous pressure indications. Mismatched pressure ratings can result in leakage or personal injury.

1. Shut down engine.
2. Turn ground disconnect switch to the DISABLE position.
3. Loosen fill cap on the tank to release any residual pressure in the system.
4. Install combination flow meter **(3)**, needle valve **(2)**, pressure gauge **(1)** as shown to the outlet port of the pump.

Continued on next page...

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5. Remove hose from inlet of control valve and connect it to the inlet of flow meter **(3)**, needle valve **(2)**, pressure gauge **(1)** combination tool as shown. If a combination unit is not available, install a single flow meter, needle valve, or pressure gauge.
6. Connect a length of hose from the outlet port of the flow meter to the connector at the oil filter or route it directly to the oil tank. Fasten it securely.
7. Open needle valve **(2)** fully (turn counterclockwise). The pressure gauge **(1)** will be parallel with the connector at the inlet port of flow meter.
8. Install a vacuum gauge **(4)** in parallel with the connector at the inlet port of pump.
9. Turn ground disconnect switch to the ENABLE position. Start engine and inspect test equipment connectors for leaks.

NOTE: If catastrophic failure is suspected, do not run engine for longer than is absolutely necessary to determine its condition. If metal fragments are found in the hydraulic lines, outlet port of pump, return filter, and/or tank, **do not** restart the pump. Replace pump.

10. Allow system to warm up to approximately 130°F (54°C). If needed, cycle a machine function to aid in warming the oil. Observe pyrometer **(5)**.
11. Set engine speed to full throttle (2350 rpm). Verify engine speed on the TEC 2000 display.

NOTE: The conveyor pump shaft is integral to the left attachment pump. Therefore, the pump speed must be verified. The engine must be able to maintain full throttle to achieve desired pump flow.

12. Record on worksheet:

- The pump (no-load) input shaft speed, and in this case, the engine RPM. Ensure TEC 2000 display indicates 2350 rpm.
- The pump inlet restriction indicated on the vacuum gauge **(4)**.

NOTE: If the inlet restriction is within design specification 5″ Hg (127 mm) continuous max., continue with test procedure. If pump inlet restriction is inconsistent with design specification, refer to page 4B-3 and ensure fluid level is correct and suction screen is not clogged. Continue with test procedure when pump inlet restriction is within design specification.

Continued on next page...

13. Operate pump at no-load. Record on test worksheet:

- Flow indicated on flow meter **(3)**.
- Pressure indicated on pressure gauge **(1)**.
- Fluid temperature indicated on pyrometer **(5)**.

14. Gradually load pump by restricting the flow with needle valve **(2)** (turn clockwise). Stop when pressure reaches 100 psi (6.9 bar), more than no-load pressure.

15. Continue increasing the pressure increments of 100 psi (6.9 bar), plotting the flow and pressure at each 100 psi (6.9 bar) increment on test worksheet. Stop the test procedure when 2500 psi (172 bar) is reached.

16. With engine operating at full load (full pump flow passing over relief valve), record on test worksheet:

- Engine speed indicated on TEC 2000 display.
- Fluid temperature indicated on pyrometer **(5)**.

17. Open needle valve **(2)** fully (turn counterclockwise) and reduce artificial load on pump.

18. Shut down engine and analyze test results.

19. At conclusion of test procedure, remove test equipment, reconnect hydraulic lines and tighten connections.

20. Start engine and check connections for leaks.

Analyzing Test Results

Diagnostic Observation 1:

- Flow meter **(3)** indicates a nominal flow decrease as the pressure drop across the pump ports increases. The flow decrease does not exceed the the maximum leakage specification of the pump - 6 gpm (23 L/min) with a nominal decrease in engine speed.
- The operating temperature of the fluid indicated on pyrometer **(5)** remains within design specification.
- The engine speed indicated on TEC 2000 display remains within design specification.
- Pump inlet restriction indicated on vacuum gauge **(4)** remains within design specification 5″ Hg (127 mm) continuous max.

Diagnosis - The pump appears to be in satisfactory operating condition. Refer to page **9B-10** and test directional control valve assembly.

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Diagnostic Observation 2:

- Pyrometer **(5)** indicates a moderate increase in the operating temperature of the fluid.
- Engine speed indicated on TEC 2000 display remains within design specification.
- Pump inlet restriction indicated on vacuum gauge **(4)** remains within design specification 5″Hg (127 mm) continuous max.

Diagnosis - The condition of the pump may be marginal. If there is an abnormal variation (reduction) in actuator speed which causes an unacceptable loss and/or a marked increase in the operating temperature of the fluid, the pump should be replaced.

Diagnostic Observation 3:

- Flow meter **(3)** indicates a progressive flow loss as the pressure drop across the pump ports increases. The flow loss exceeds 30% of the theoretical or (no-load) flow - 6 gpm (23 L/min) max.
- Pyrometer **(5)** indicates a progressive increase in operating temperature of the fluid which does not appear to level off.
- Engine speed indicated on TEC 2000 display remains within design specification.
- Pump inlet restriction on vacuum gauge **(4)** remains within design specification 5″ Hg (127 mm) continuous max.

Diagnosis - There appears to be excessive leakage across ports of pump. Replace pump.

Directional Control Valve DC1 - Test

The conveyor directional control valve has a built-in pressure relief valve. This valve is not used to set system pressure, the pressure relief valve installed on the inlet of the control valve is used to control system pressure at 2500 psi (172 bar). Refer to page **9B-5** for information on checking the relief pressure.

NOTE: Contaminants in hydraulic oil, over a period of time, can build up between the moving parts and housings and cause valve spools, check balls, and other components to stick. Leaking O-ring seals and backup washers can also affect the output flow of valves.

Continued on next page...

Inspecting for excessive wear would involve removing the valve spool and checking the valve seats, O-ring seals, backup washers, spools, and other internal components. Replace any seals that are visually worn. If any other valve components are worn, the valve assembly will need replaced. Refer to page 9C-3 of the Cross Conveyor Repair section for information replacing or repairing the control valve.

Analyzing Test Results

Diagnostic Observation 1:

The visual inspections fail to find any worn or damaged valve seals or internal components.

Diagnosis - The condition of the valve appears to be OK. the motor(s) is most likely to be the component causing the malfunction in the circuit. Testing the motor for excessive leakage can be quite labor intensive. Compared to the price of a new motor it may not be cost effective. Therefore, it is up to the discretion of the technician whether or not to perform the motor test. If not testing, replace motor at this point. If testing the motor(s) is desired, see Motors B1, B2, B3 - Test.

Diagnostic Observation 2:

The visual inspections find worn or damaged valve seals, valve seats, spool, other internal components.

Diagnosis - The condition of the valve appears to be faulty and is most likely to be the component causing the malfunction in the circuit. Repair or replace the control valve assembly. Refer to page 9C-3 for information.

Motors B2, B3, B4 - Test

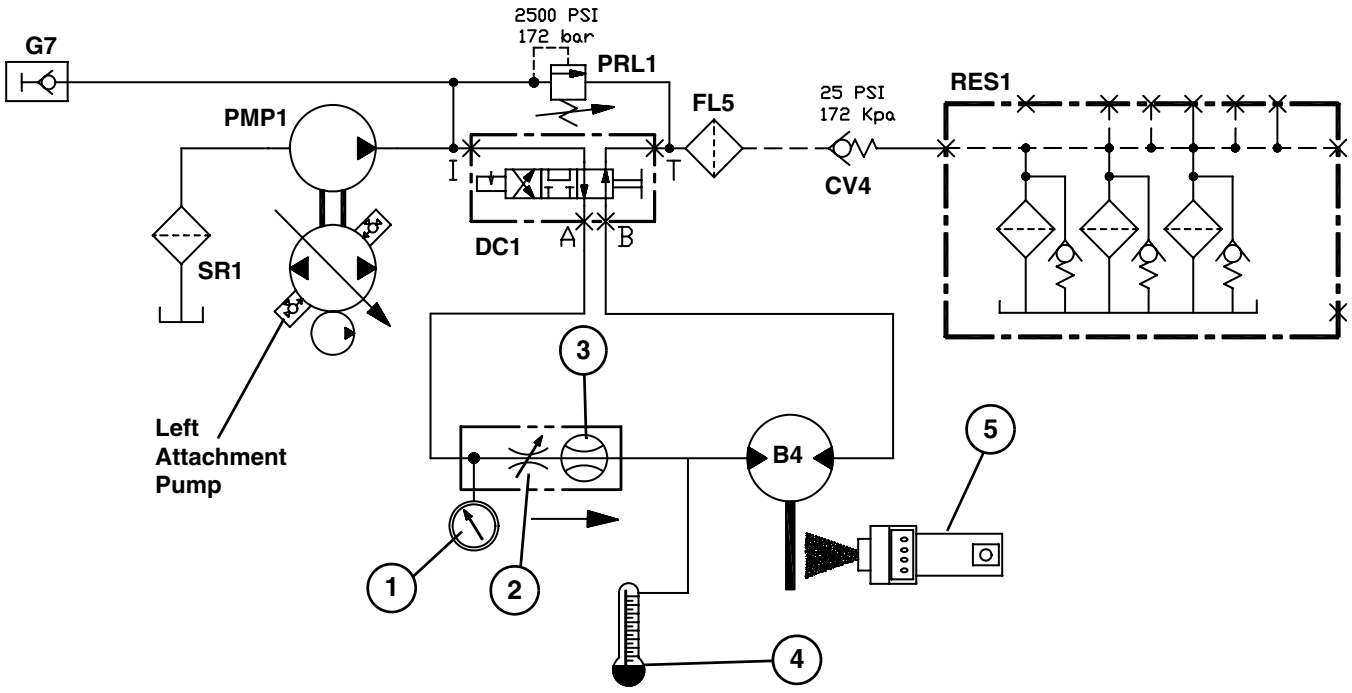
The illustration on the following page depicts the motor(s) being tested in the clockwise rotation. Damage to the test equipment can occur if it is not installed correctly. Note the direction of the arrow on the flow meter when installing. The curved conveyor procedures will test the motors individually. The right motor will be removed from the circuit and tested after the left motor.

NOTE: The motor(s) should be tested in both directions. When testing opposite direction, install test equipment to the opposite port of motor.

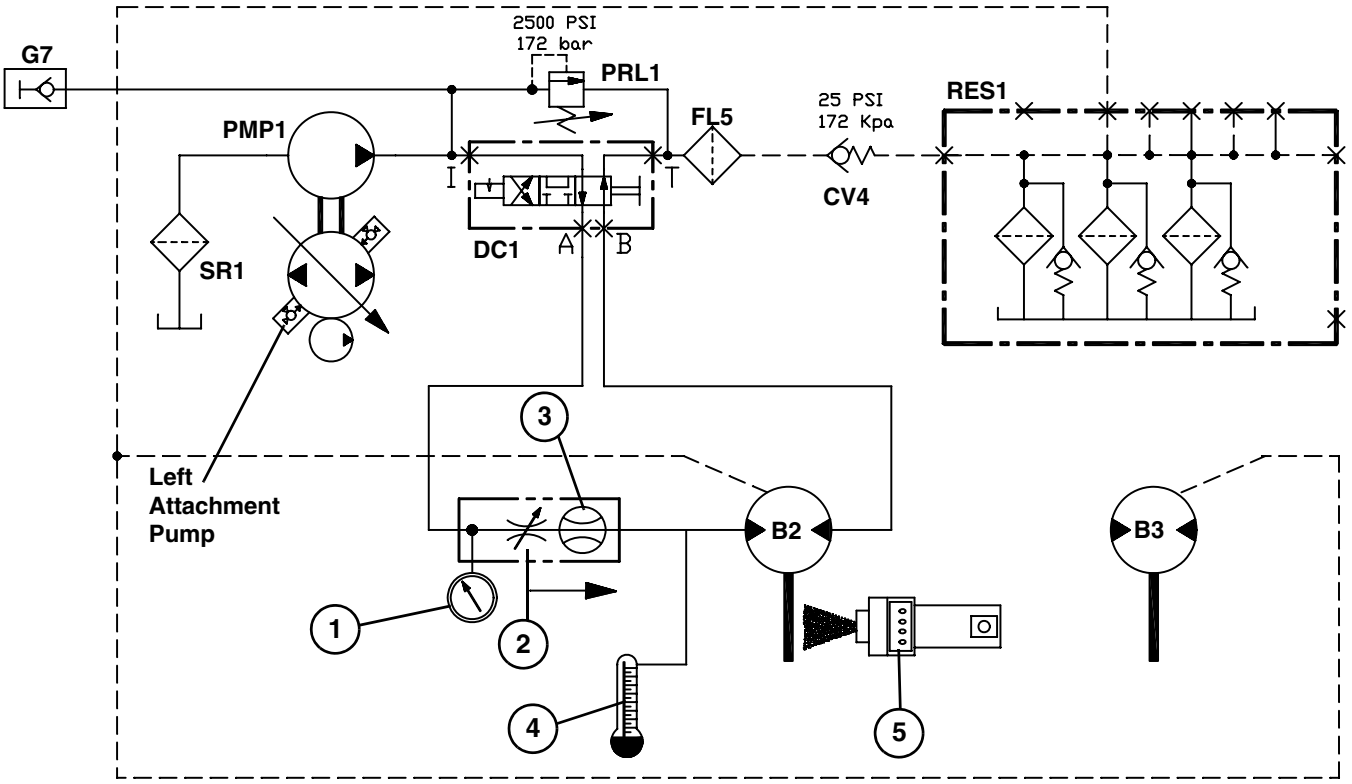
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Flat Conveyor



Curved Conveyor



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IMPORTANT: Ensure any hoses or fittings that are added to the test equipment are the same size and rating as hoses and fittings installed in the hydraulic circuit. Mismatched hose or fitting sizes can result in erroneous pressure indications. Mismatched pressure ratings can result in leakage or personal injury.

1. Shut down engine.
2. Make a photocopy of the appropriate motor test worksheet on page 9B-17 or page 9B-18.
3. Turn ground disconnect switch to the DISABLE position.
4. Loosen fill cap on the tank to release any residual pressure in the system.
5. Refer to the appropriate illustration on the previous page and install combination flow meter **(3)**, needle valve **(2)**, pressure gauge **(1)** as shown in series with the inlet port of left motor B2. If a combination unit is not available, install a single flow meter, needle valve, or pressure gauge.
6. If testing a curved conveyor, install a straight coupler fitting as shown to bypass the right motor. Refer to diagram on page 9B-19.
7. Open needle valve fully (turn counterclockwise).
8. To conduct the test, the motor(s) need to be disconnected from the conveyor assembly. The needle valve is used to generate an artificial load. Refer to page 9C-7 for removal procedure. Ensure motor is secured or clamped to the conveyor frame while testing to keep it from moving.

NOTE: If catastrophic failure is suspected, do not run engine for longer than is absolutely necessary to determine the motor's condition. If metal fragments are found in hydraulic lines, inlet or outlet ports of motor, or return filters, **do not** operate the motor. Replace motor.

9. Turn ground disconnect switch to the ENABLE position. Start engine and inspect test equipment connections for leaks.
10. Allow system to warm up to approximately 130°F (54°C). If needed, cycle a machine function to aid in warming the oil. Observe pyrometer **(4)**.

NOTE: For accurate test results, check and adjust, if necessary, the pressure relief valve. Refer to page 9B-4.

NOTE: Pump flow is proportional to motor input shaft speed. If there is a reduction in pump flow because of engine speed, it will directly affect motor shaft speed. It is necessary to determine pump shaft speed prior to testing. The engine RPM must be correct and used to determine pump shaft speed.

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11. Start engine and set engine speed to full throttle (2350 rpm) if testing a flat conveyor motor or (1200 rpm) if testing a curved conveyor motor. Verify engine speed on TEC 2000 LCD display.
12. Actuate control valve (full flow) and record on test worksheet:

- No-load pressure indicated on pressure gauge **(1)**.
- No-load motor shaft speed indicated on tachometer **(5)**.
- No-load flow into motor indicated on flow meter **(3)**.
- Fluid temperature indicated on pyrometer **(4)**.

13. Gradually load system by restricting the flow into the motor with needle valve **(2)** (turn clockwise). Load system in 100 psi (6.9 bar) increments.
14. At each 100 psi (6.9 bar) increment, record on the graph of test worksheet:

- Pressure indicated on pressure gauge **(1)**.
- Motor shaft speed indicated on tachometer **(5)**.
- Flow into motor indicated on flow meter **(3)**.

15. Stop test procedure when the value of the relief valve is reached at 2500 psi (172 bar).
16. Record on test worksheet, the full-load engine RPM indicated on TEC 2000 LCD display.
17. Open needle valve fully (turn counterclockwise).
18. Shut down engine and analyze test results.
19. At conclusion of test procedure, remove test equipment. Reconnect hydraulic lines and tighten connections.
20. Install motor back onto the conveyor frame. Start engine and check connections for leaks.

Analyzing Test Results

Diagnostic Observation 1:

- Flow meter **(3)** indicates a moderate to high flow decrease as needle valve **(2)** creates an artificial load on the hydraulic system.
- Tachometer **(5)** indicates a reduction in motor shaft speed which is proportional to the flow decrease.

Continued on next page...

- Pyrometer **(4)** indicates a moderate increase in the operating temperature of the fluid.
- Engine speed remains within design specification.

Diagnosis - The loss in motor shaft speed is proportional to the decrease of flow into motor. This indicates that the motor is OK. The pump has also been tested at this point and proven to be within design specification. The directional control valve has been inspected and visually appeared to be OK but is most likely leaking excessively internally. Replace valve. Refer to page 9C-3 for information.

Diagnostic Observation 2:

- Flow meter **(3)** indicates a marginal flow decrease as needle valve **(2)** creates an artificial load on the hydraulic system. The flow decrease is not more than the anticipated loss relative to the maximum leakage specification of pump, and nominal decrease in engine speed.
- Tachometer **(5)** indicates a progressive decrease in motor shaft speed as the load at the motor output shaft increases during a normal load cycle. The speed decrease approaches, or exceeds, the maximum design specification of motor no-load speed.
- Pyrometer **(4)** indicates a progressive increase in the operating temperature of the fluid which does not appear to level off.
- Engine speed remains within design specification.

Diagnosis - If the flow meter indicates that the flow into motor remains within the design specification of the system, and the tachometer indicates a speed decrease which causes an unacceptable loss in motor shaft speed, leakage across the motor is excessive. Replace motor. Refer to page 9C-7 and page 9C-8 for information.

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Pump Worksheet

Specifications and Tolerances

Engine Speed Set @ 2350 rpm

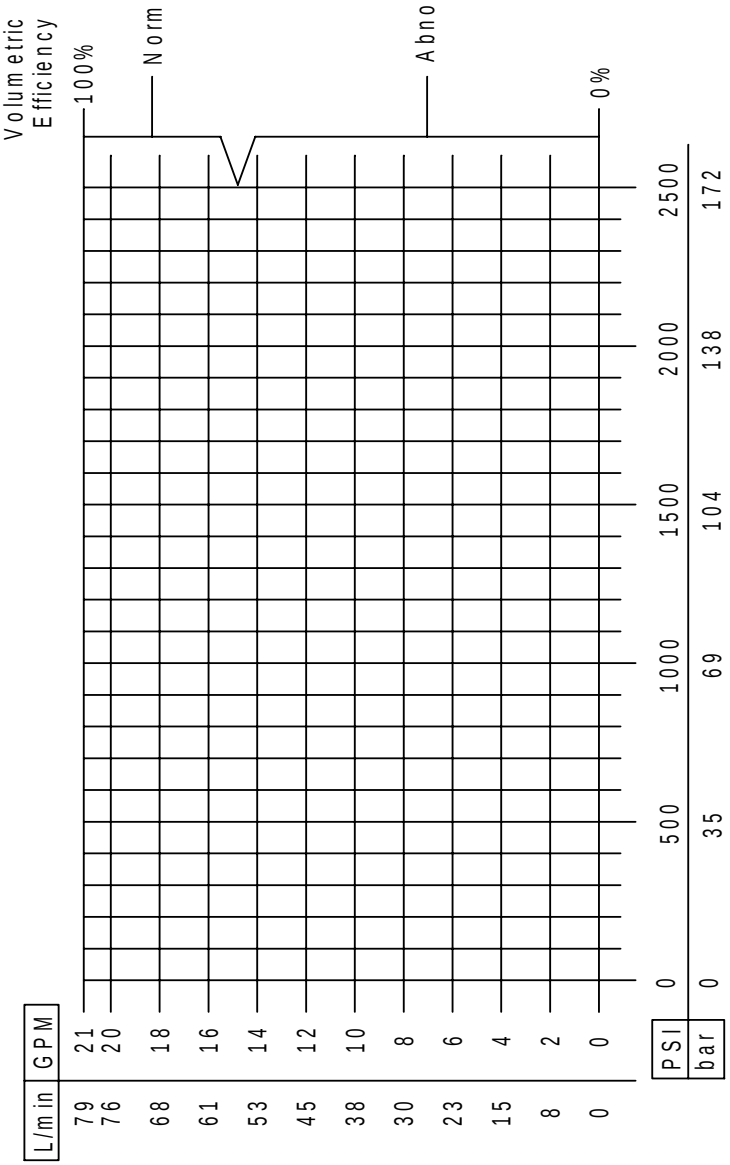
Pump displacement: 1.74 cid (28 cc)

Tested to 2500 psi (172 bar)

Pump Inlet Restriction: 5" Hg (127 mm) Continuous Max.

Nominal Case Drain Flow 4 gpm (15 L/min)

Maximum Case Drain Flow 6 gpm (23 L/min)



Engine No-Load Speed _____ RPM

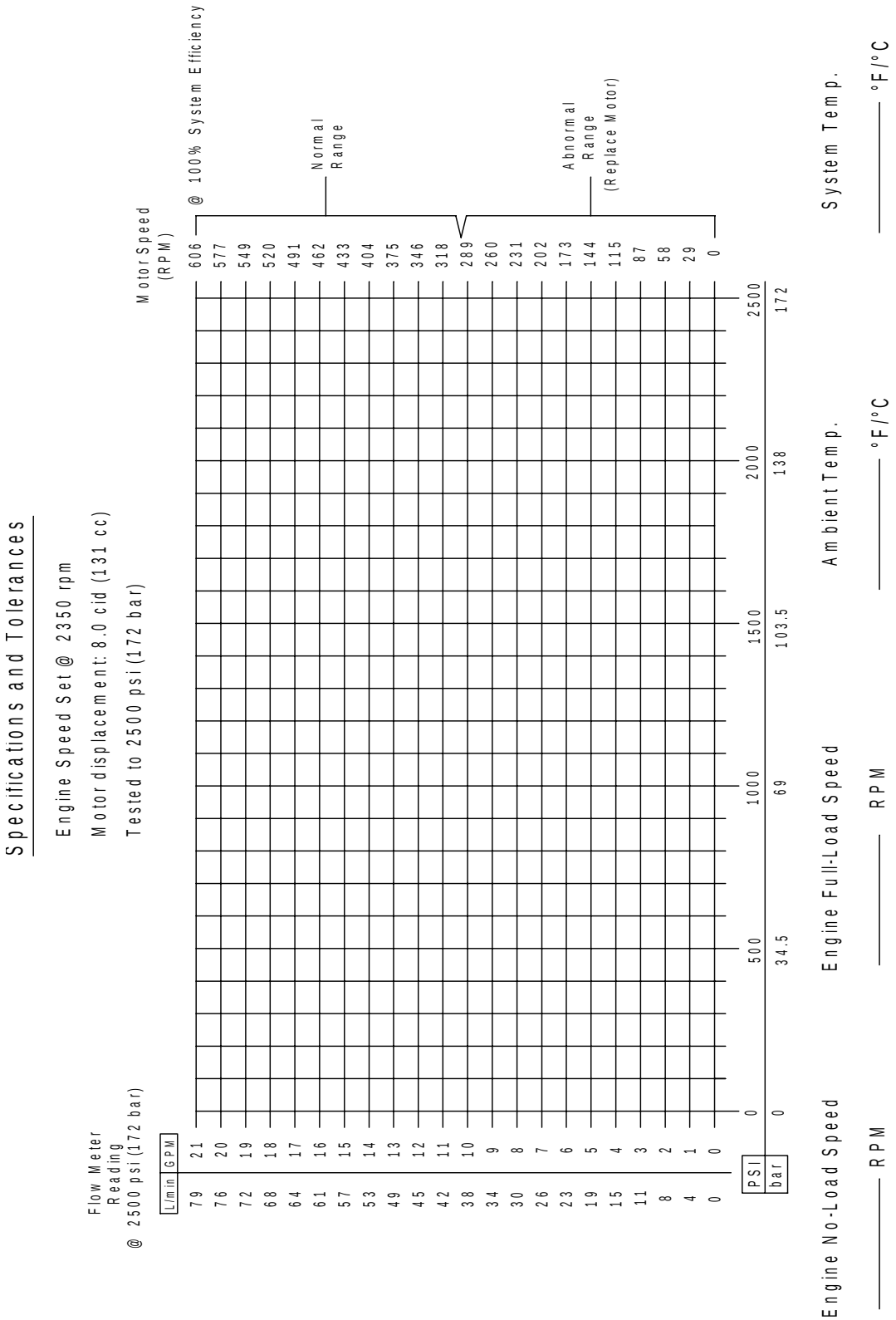
Engine Full-Load Speed _____ RPM

Ambient Temp. _____ °F/°C

System Temp. _____ °F/°C

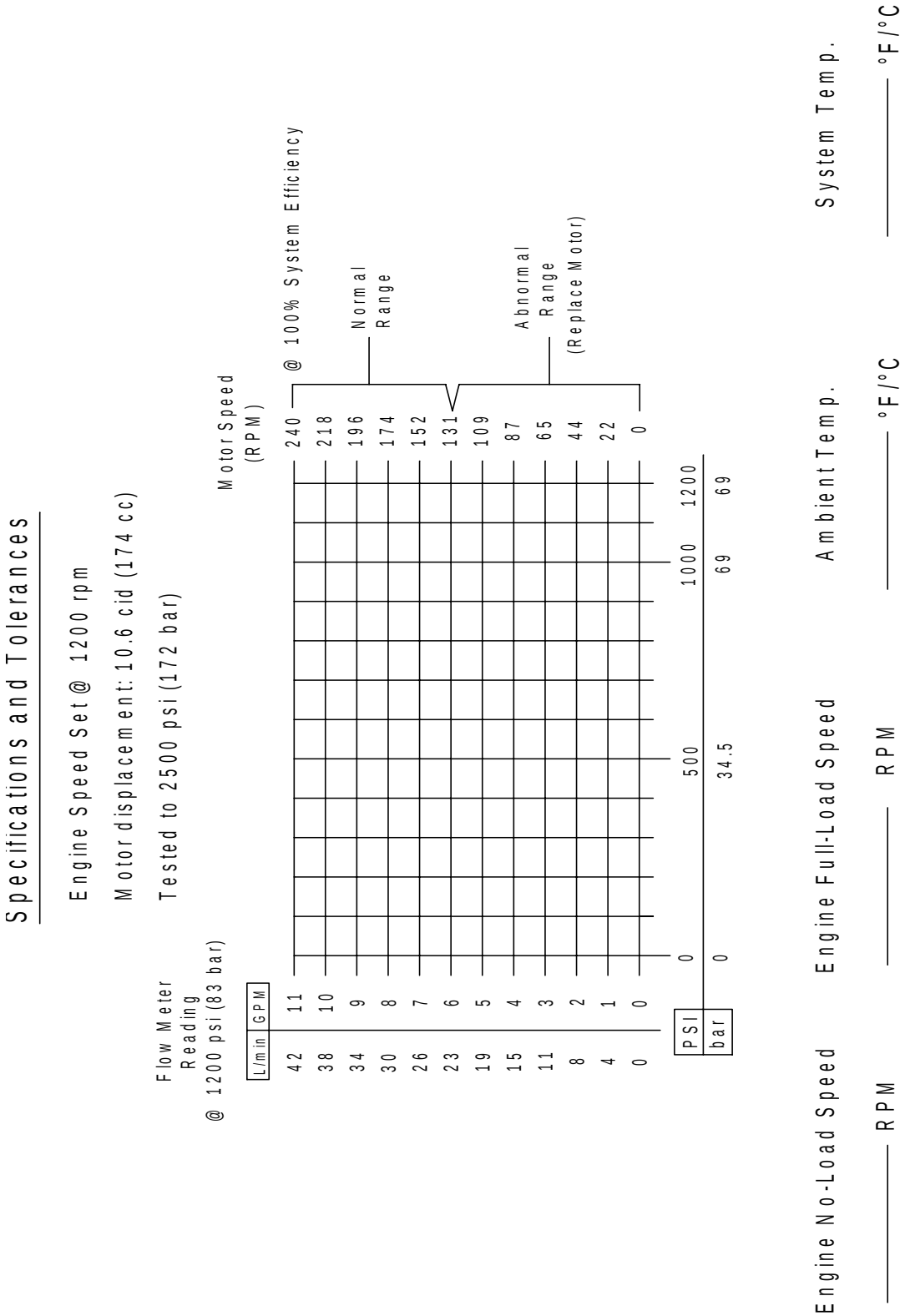
Inlet Restriction _____ in/mm Hg

Motor Worksheet (Flat Conveyor)

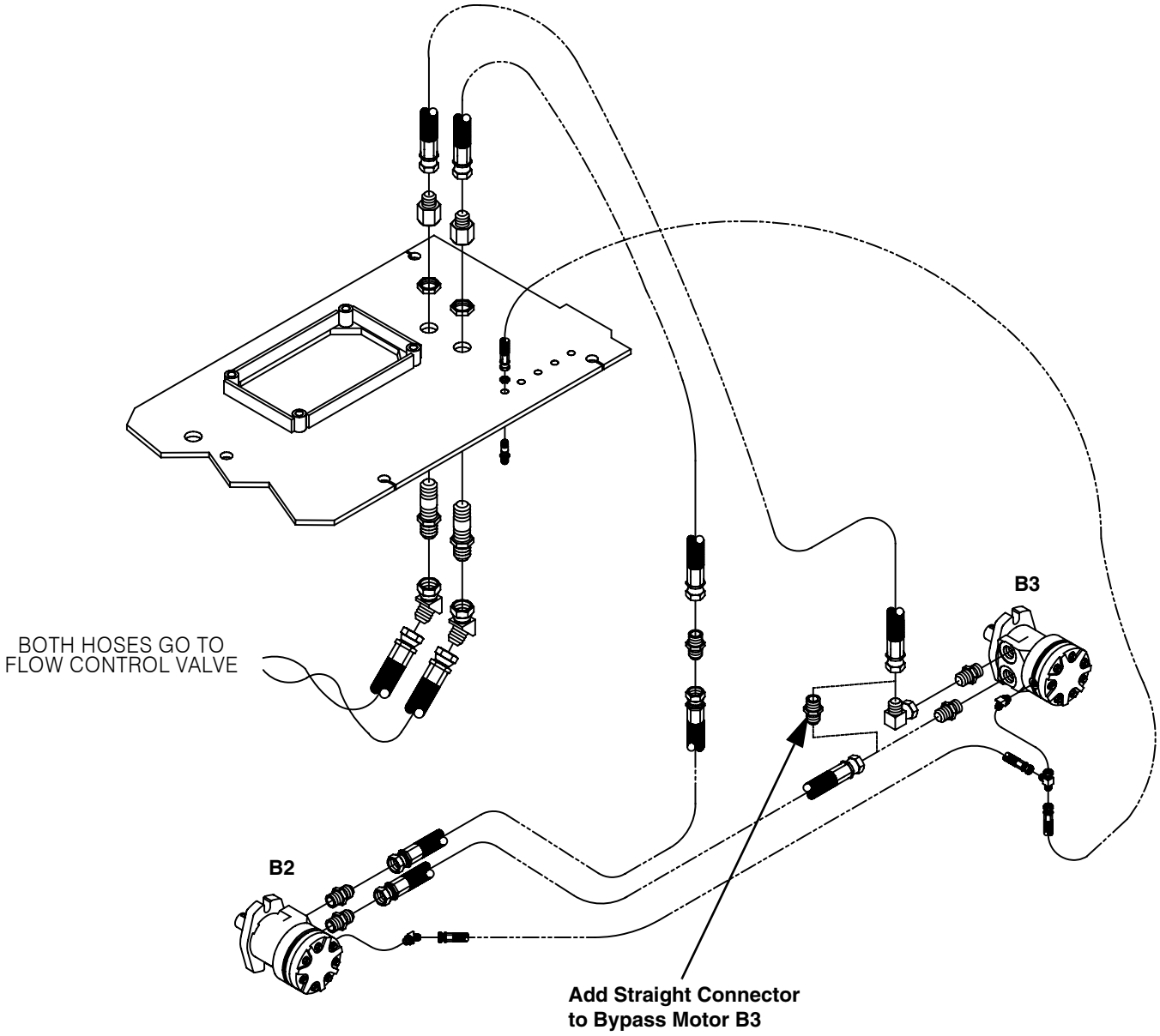


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Motor Worksheet
(Curved Conveyor)



Curved Conveyor Motor Connections



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Chapter 9: Cross Conveyor Subsystem

Section C: Repair

INTRODUCTION

Components

This section consists of repair procedures including the removal, replacement, installation, repair, and adjustments of those hydraulic and mechanical components responsible for operation of the cross conveyor.

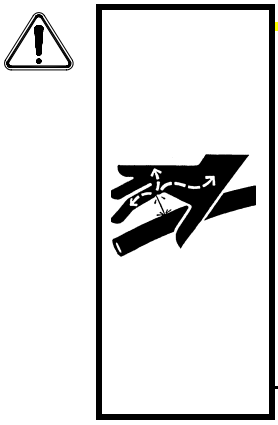
Hydraulic:

- Pump PMP1
- Directional Control Valve DC1
- Relief Valve PRL1
- Conveyor Drive Motor B2, B3, B4

Mechanical:

- Complete Conveyor Assembly
- Conveyor Belt and Flashing
- Conveyor Paddle Wheel Drive Bearings
- Conveyor Shift Gearbox

HYDRAULIC REPAIR



WARNING: Pressurized fluid can penetrate body tissue and result in serious injury or death. Leaks can be invisible. Keep away from any suspected leak. Relieve pressure in the hydraulic system before searching for leaks, disconnecting hoses, or performing any other work on the system. If you must pressurize the system to find a suspected leak, use an object such as a piece of wood or cardboard rather than your hands. When loosening a fitting where some residual pressure may exist, slowly loosen the fitting until oil begins to leak. Wait for leaking to stop before disconnecting the fitting. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

Cleanliness is extremely important when replacing or repairing hydraulic components. Work in a clean area. Before disconnecting hoses, thoroughly clean the port areas of pump, valve, cylinders and motors to be removed. Thoroughly clean outside of each component to be reinstalled.

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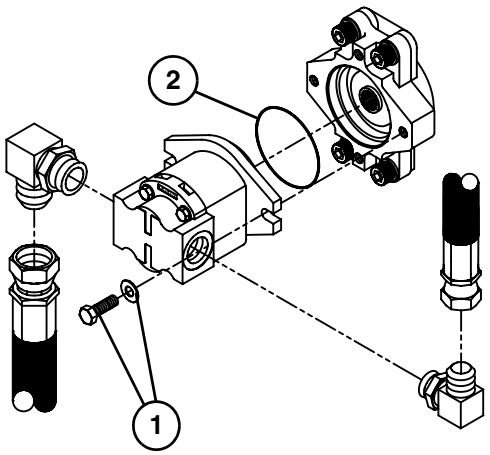
Pump PMP1

The cross conveyor pump can be replaced as a complete unit or repaired by installing a new seal kit.

Remove

To remove pump:

1. Follow *"Shutdown Procedure," page* **2-1**.
2. Label and disconnect each hose from pump. Cap all fittings and plug all hoses.
3. Remove bolts and washers **(1)** securing pump to attachment pump. Remove pump.
4. Remove and discard old O-ring **(2)**.



Install

Reverse removal procedure to install new pump.

- Remove fittings from old pump and install in the same orientation to the new pump.
- Apply Molykote G-N paste (P/N 94469003) to spline shaft of pump.
- Install new O-ring **(2)**.
- Torque bolts **(1)** according to standard torque charts.

Pump Seals

A seal kit is available for repairing the pump.

Replace

To replace seals:

1. Refer to previous page and follow instructions for removing pump.
2. Refer to www.us.rexroth.com on the internet for complete instructions on replacing the seals.

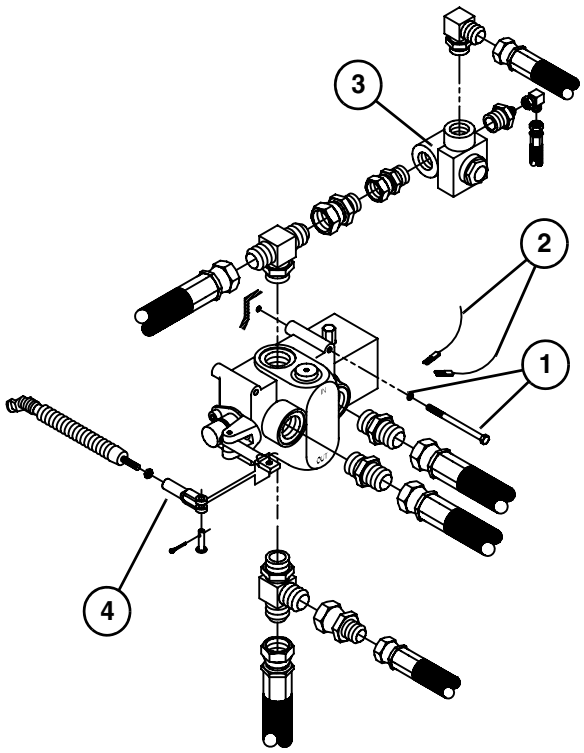
Directional Control Valve DC1

The directional control valve can be replaced as a complete unit or repaired with a seal kit. The neutral safety switch is also replaceable.

Remove

To remove valve assembly:

1. Follow *"Shutdown Procedure," page* **2-1**.
2. Label and disconnect each hose from valve. Cap all fittings and plug all hoses.
3. Remove in-line relief valve **(3)**.
4. Unplug wire harness **(2)** from neutral safety switch.
5. Remove control cable assembly **(4)** from valve lever.
6. Remove four bolts and washers **(1)** securing valve to machine. Remove valve.



Install

Reverse removal procedure to install new valve.

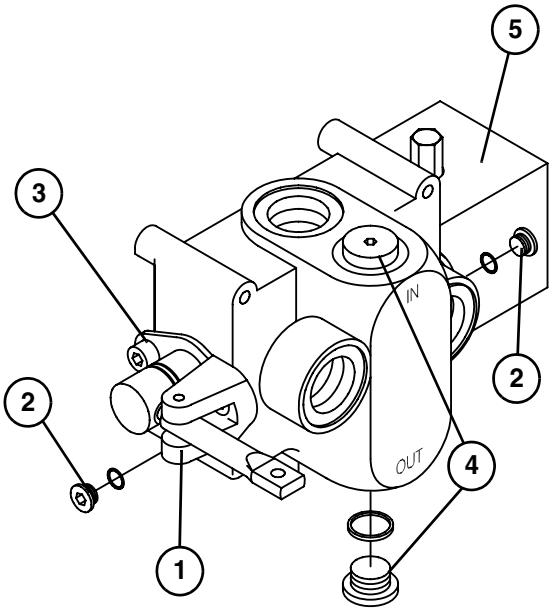
- Torque bolts **(2)** according to standard torque charts.

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Directional Control Valve Seals

Replace

To replace main spool seals:



1. Remove handle bracket **(1)**, seal retainer **(3)**, and associated mounting hardware.
2. Remove switch block **(5)**, seal retainer, and associated mounting hardware from opposite side.
3. Remove spool seals. Note orientation of the spool wipers and seals when removing.
4. Thoroughly clean O-ring counterbores of each end.
5. Lightly oil new seals. Slide over valve spools and insert in seal counterbores.

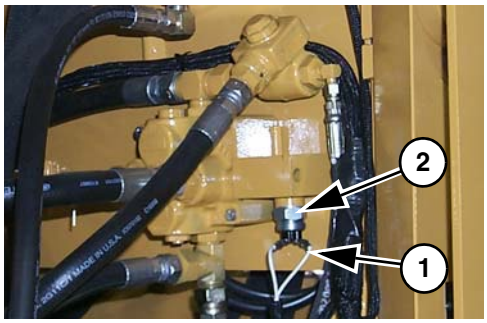
To replace remaining valve seals:

6. Remove relief valve assembly **(4)**.
7. Remove old seals. Note orientation of backup washers and O-rings when removing.
8. Remove shuttle spool plugs **(2)**.
9. Lightly oil new seals and install in order old ones were removed.

Neutral Safety Switch

Replace

To replace the switch:



1. Disconnect wire harness **(1)**.
2. Unscrew switch **(2)** from switch block.
3. Install new switch, connect wire harness terminal.

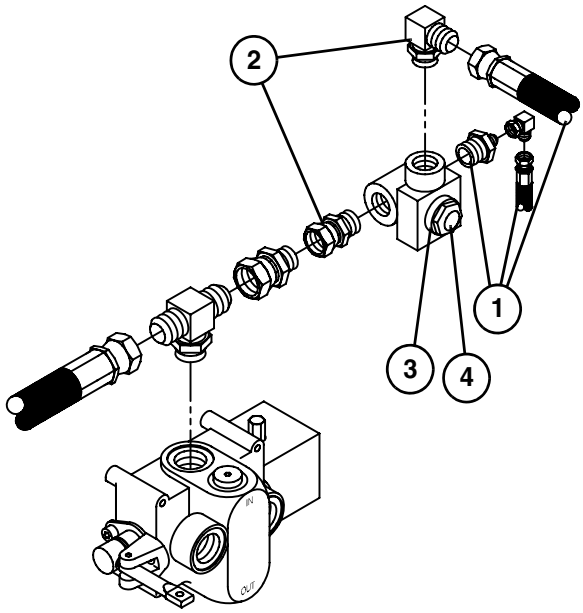
Relief Valve PRL1

The relief valve can be replaced as a complete unit or repaired with a seal kit. A service kit that includes a replaceable poppet and piston ring is also available to repair the valve.

Remove

To remove relief valve:

1. Follow *"Shutdown Procedure," page* **2-1**.
2. Label and disconnect hoses and fittings **(1 & 2)**. Remove valve.



Install

Reverse removal procedure to install new valve.

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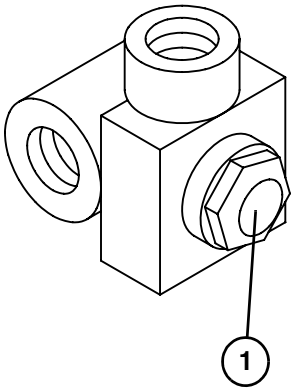
Relief Valve Seals

Replace

1. Remove relief cartridge assembly **(3)** by turning large hex counterclockwise.
2. Remove end cap **(4)** containing the spring, shims, and poppet, being careful not to lose any shims.
3. Remove all old seals. Note orientation of the backup washer and O-rings. This will ensure new seals are installed correctly.
4. Remove poppet assembly if replacing.
5. Install new seals and/or poppet assembly in order old ones were removed.
6. Inspect manifold cavity for burrs or other irregularities which could damage O-rings during installation.
7. Dip valve relief body in clean, filtered oil.
8. Screw cartridge in by hand until O-ring is met.
9. Torque to 30–35 ft-lb (40–47 Nm).

Relief Valve - Adjust

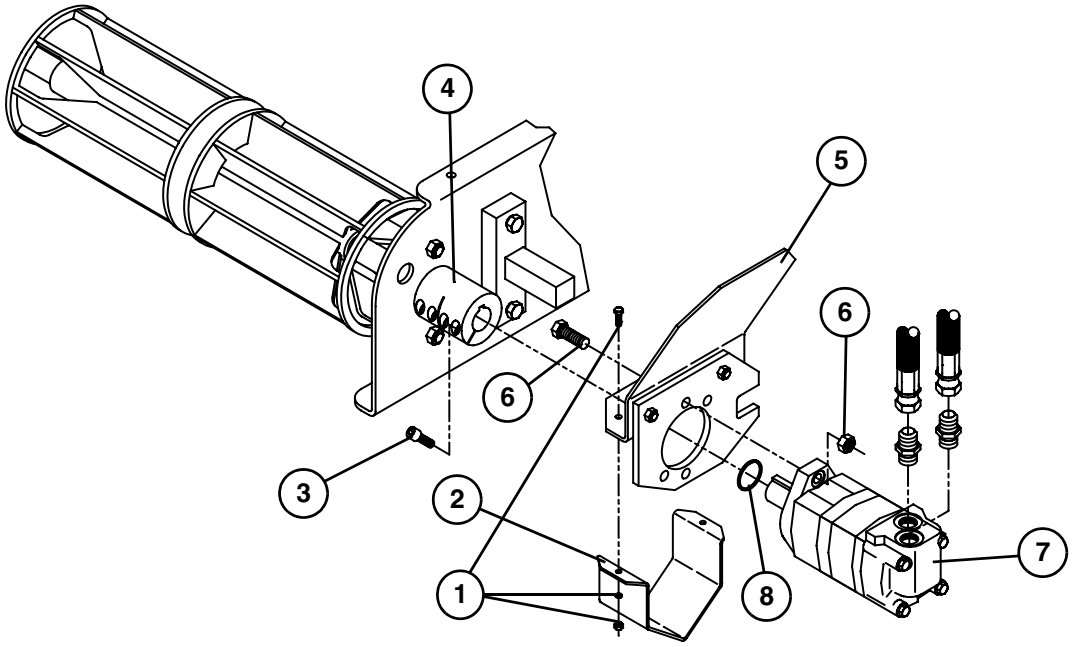
1. Remove end cap **(1)** containing the spring, shims, and poppet, being careful not to lose any shims.
2. Inspect components. Clean and replace any damaged components.
3. Add or subtract shims under the spring as necessary.
   - A 0.010″ shim will change the pressure setting approximately 100 psi (7 bar). A 0.020″ shim will change the pressure setting approximately 200 psi (14 bar). A 0.040″ shim will change the pressure setting approximately 400 psi (28 bar).



4. Install relief valve components into the valve body.
5. Install end cap with O-ring and tighten securely.

Flat Conveyor Drive Motor B4

The flat cross conveyor motor B4 can be replaced as a complete unit or repaired by installing a new seal kit. A dust seal is also available for replacement.



Remove

To remove a motor:

1. Follow *"Shutdown Procedure," page* **2-1**.
2. Label and disconnect each hose from motor. Cap all fittings and plug all hoses.
3. Remove mounting hardware **(1)** and coupler shield **(2)**.
4. Loosen two socket head screws **(3)** on motor side of coupler **(4)**.
5. Leave motor attached to the torque arm and shield assembly **(5)** and slide complete assembly out of coupler **(4)**.
6. Remove bolts and nuts **(6)** securing motor to conveyor torque arm and motor shield **(5)**. Remove motor.

Install

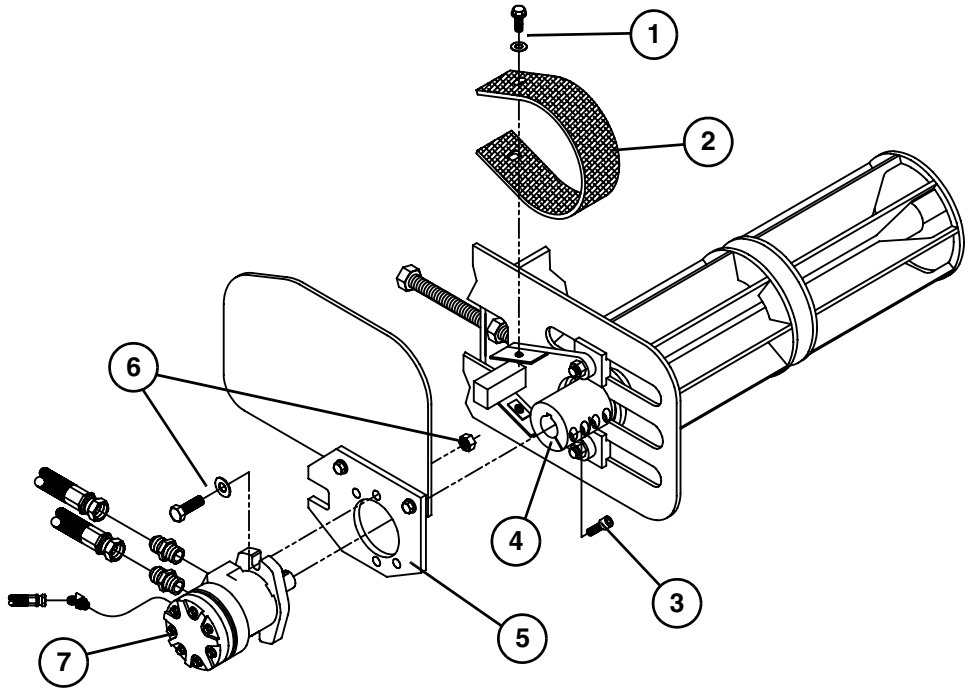
Reverse removal procedure to install new motor.

- Check dust seal **(8)**. Replace seal if damaged or leaking.
- Torque all bolts according to standard torque charts.

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Curved Conveyor Drive Motors B2 & B3

A repair kit is not available for the curved cross conveyor motors B2 & B3. The motors must be replaced as a complete unit.



Remove

To remove a motor:

1. Follow *"Shutdown Procedure," page* **2-1**.
2. Label and disconnect each hose from motor. Cap all fittings and plug all hoses.
3. Remove mounting hardware **(1)** and rubber flashing **(2)**.
4. Loosen two socket head screws **(3)** on motor side of coupler **(4)**.
5. Leave motor attached to the torque arm and shield assembly **(5)** an slide complete assembly out of coupler **(4)**.
6. Remove bolts and nuts **(6)** securing motor to conveyor torque arm and motor shield **(5)**. Remove motor **(7)**.

Install

Reverse removal procedure to install new motor.

- Torque all bolts according to standard torque charts.

MECHANICAL REPAIR

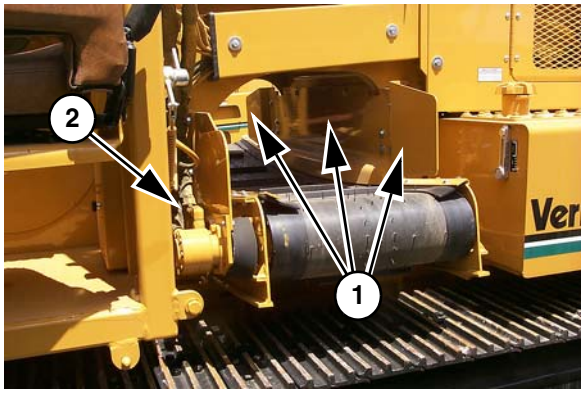
Complete Conveyor Assembly

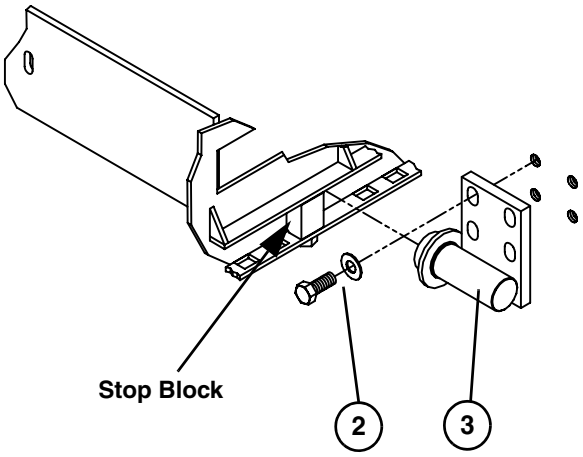
It may be necessary at times to remove the complete conveyor assembly to gain access to certain components for repair. For example, when replacing ground drive and attachment pumps.

Remove

To remove complete conveyor assembly:

1. Shift conveyor fully towards the trencher motor side of machine.
2. Follow *"Shutdown Procedure," page* **2-1**.
3. Remove three dirt shields **(1)**.
4. Label and disconnect each hose **(2)** from motor(s). Cap all fittings and plug all hoses.
5. Attach suitable lifting device to frame of conveyor. Pull conveyor out of machine until it contacts the stop blocks.
6. Remove four bolts and washers **(2)** securing roller mount assembly **(3)** from both sides of conveyor frame.
7. Continue lifting conveyor assembly from machine until clear.





Install

Reverse removal procedure to install conveyor assembly.

- Torque all bolts according to standard torque charts.

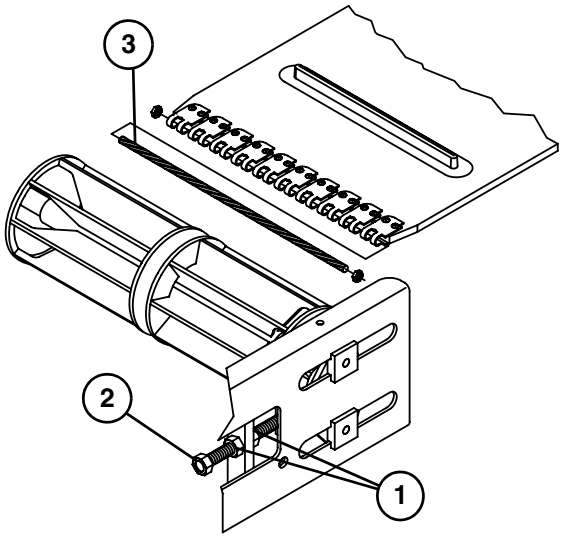
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Conveyor Belt

Remove

To remove conveyor belt:

1. Position steel cable assembly **(3)** in the conveyor belt in an accessible location.
2. Follow *"Shutdown Procedure," page* **2-1**.
3. Loosen belt tension on both sides of conveyor frame by loosening the hex nuts **(1)** on belt adjustment bolts **(2)** on both sides of conveyor.
4. Turn bolts counterclockwise evenly until there is slack in the belt.
5. Remove steel cable assembly **(3)** from belt then remove belt.



Flat Conveyor Shown

Install

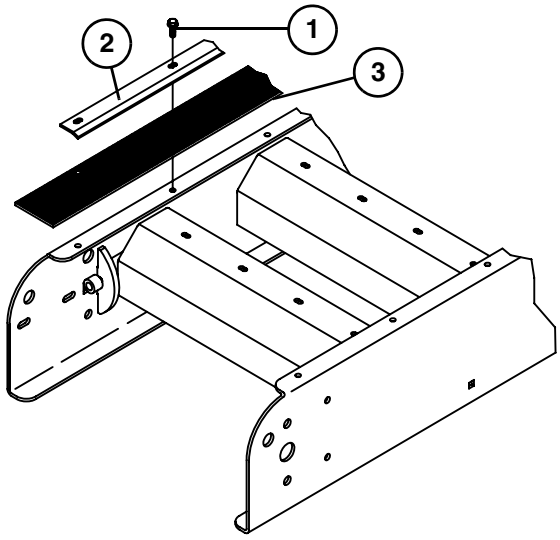
Reverse removal procedure to install new belt.

Belt - Adjust

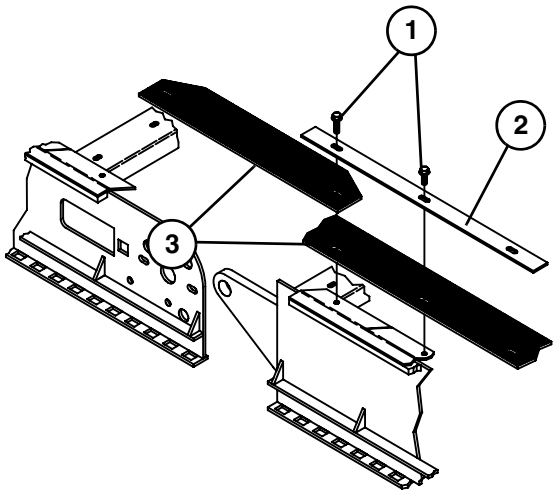
NOTE: If belt adjustment bolts are not adjusted evenly, the belt may track toward one side of conveyor.

- Adjust belt tension by turning the belt adjustment bolts **(2)** clockwise.
- Adjust belt so it tracks straight and doesn't slip under load.

Conveyor Belt Flashing



Flat Conveyor



Curved Conveyor

Remove

Replace the flashing when its worn.

1. Follow *"Shutdown Procedure," page* **2-1**.
2. Remove 18 bolts **(1)** securing hold down bar **(2)** and flashing **(3)**. Remove bar and flashing.

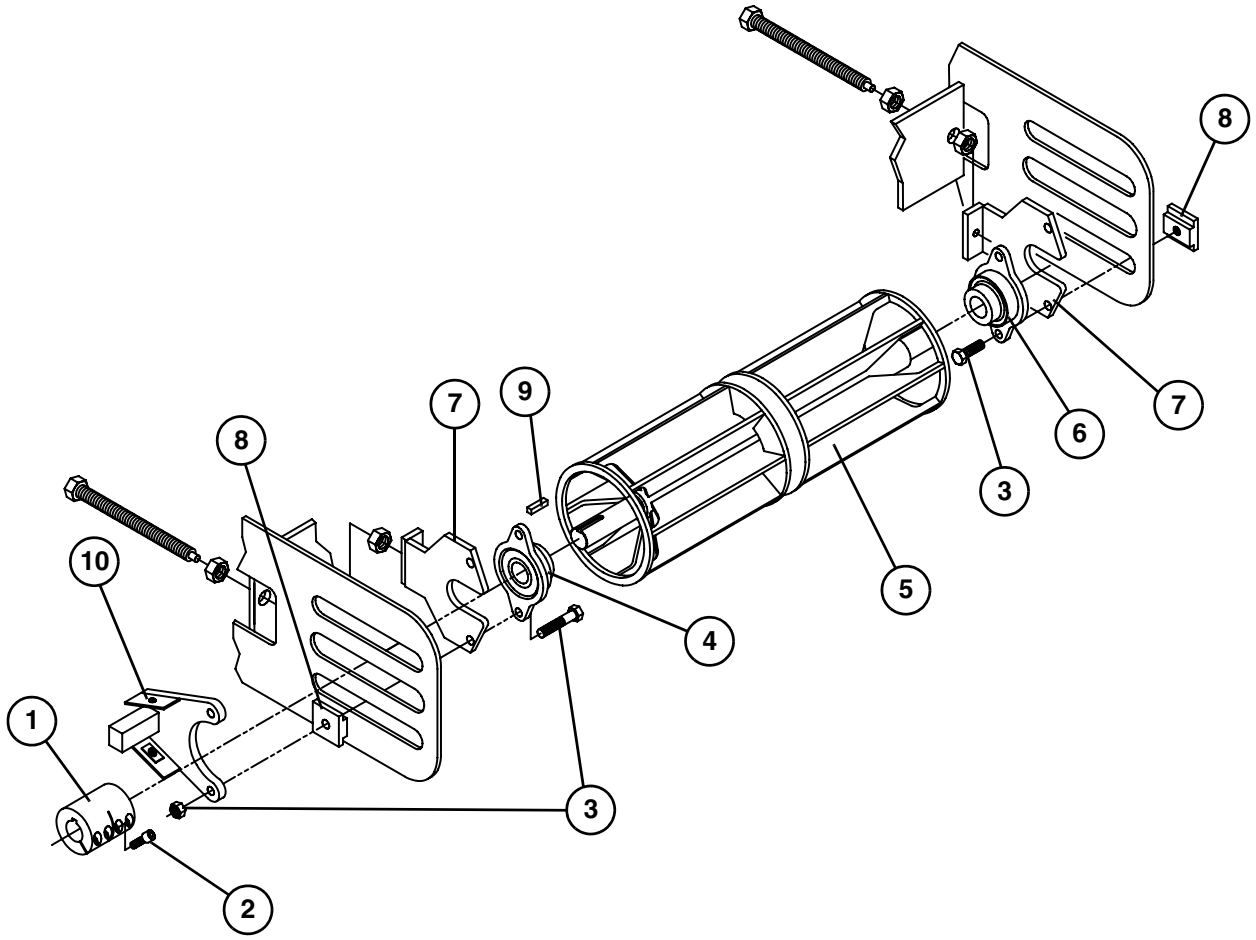
Install

Reverse removal procedure to install new flashing.

- Torque bolts **(1)** according to standard torque charts.

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Curved Conveyor Paddle Wheel Drive Bearings



Remove

1. Refer to page 9C-10 and remove conveyor belt.
2. Refer to page 9C-8 and remove hydraulic motor from end being repaired.
3. Loosen remaining two bolts **(2)** in coupler **(1)**. Remove coupler.
4. Loosen setscrews on both bearings **(4 & 6)**. This will allow the paddle wheel to slide freely in bearings.
5. Remove four bolts and nuts **(3)**, from both bearings.
6. Remove idler adjustment plates **(7)**, bearing mount blocks **(8)**, and anchor plate **(10)**.
7. Remove paddle wheel **(5)** and bearings **(4 & 6)**.

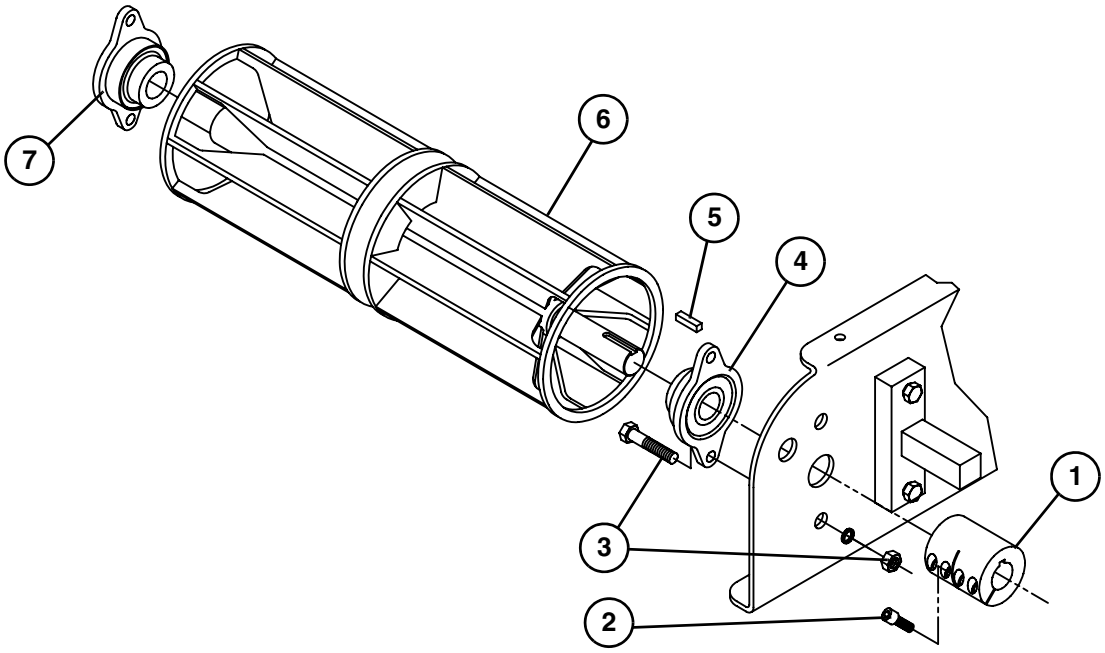
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Install

Reverse removal procedure to install new bearings.

- Apply a film of copper base anti-seize lubricant (P/N 602695583) to ends of paddle wheel shaft before installing new bearings.
- Torque all bolts according to standard torque charts.
- Ensure key **(9)** is installed in shaft and bearing **(4)**.

Flat Conveyor Paddle Wheel Drive Bearings



Remove

1. Refer to page 9C-10 and remove conveyor belt.
2. Refer to page 9C-7 and remove hydraulic motor.
3. Loosen remaining two bolts **(2)** in coupler **(1)**. Remove coupler.
4. Loosen setscrews on both bearings **(4 & 7)**. This will allow the paddle wheel to slide freely in bearings.
5. Remove four bolts and nuts **(3)** from both bearings. Remove paddle wheel **(6)** and bearings **(4 & 7)**.

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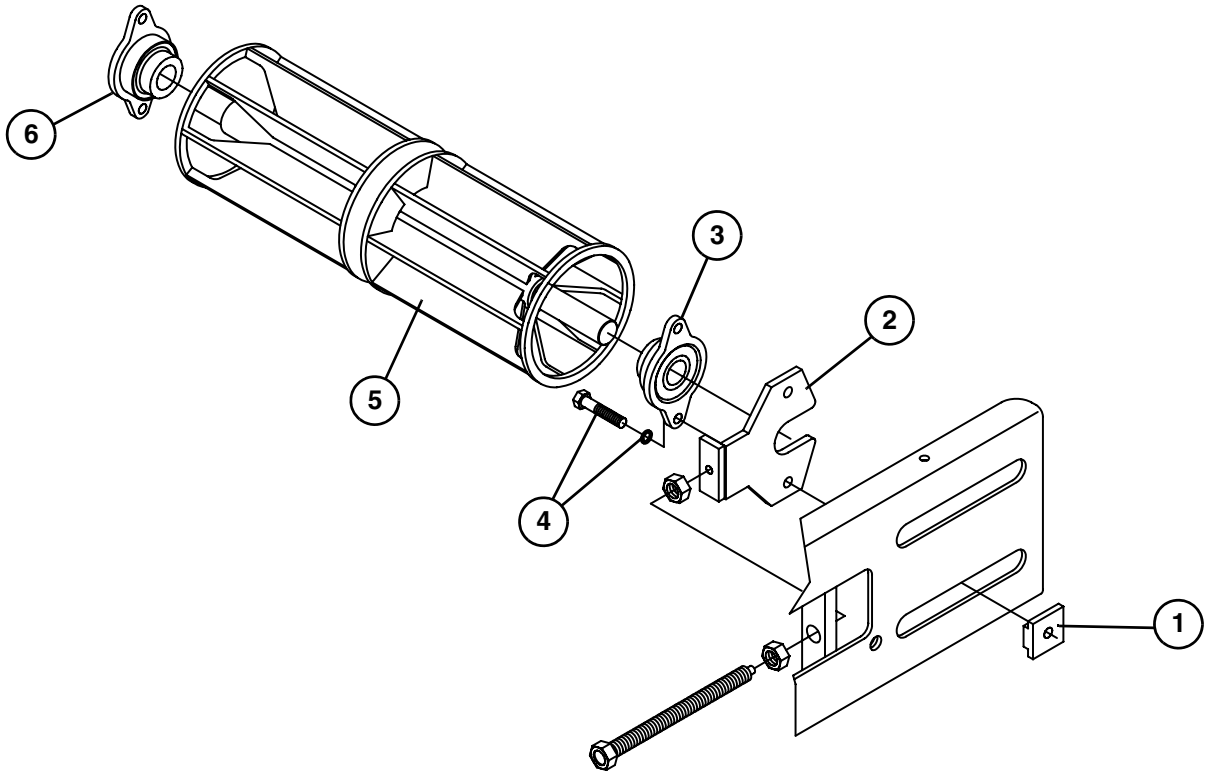
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Install

Reverse removal procedure to install new bearings.

- Apply a film of copper base anti-seize lubricant (P/N 602695583) to ends of paddle wheel shaft before installing new bearings.
- Torque all bolts according to standard torque charts.
- Ensure key **(5)** is installed in shaft and bearing **(4)**.

Flat Conveyor Idler Wheel Bearings



Remove

1. Refer to page 9C-10 and remove conveyor belt.
2. Loosen setscrews on both bearings **(3 & 6)**. This will allow the paddle wheel to slide freely in bearings.
3. Remove four bolts and nuts **(4)** from both bearings. Remove paddle wheel **(5)** and bearings **(3 & 6)**.

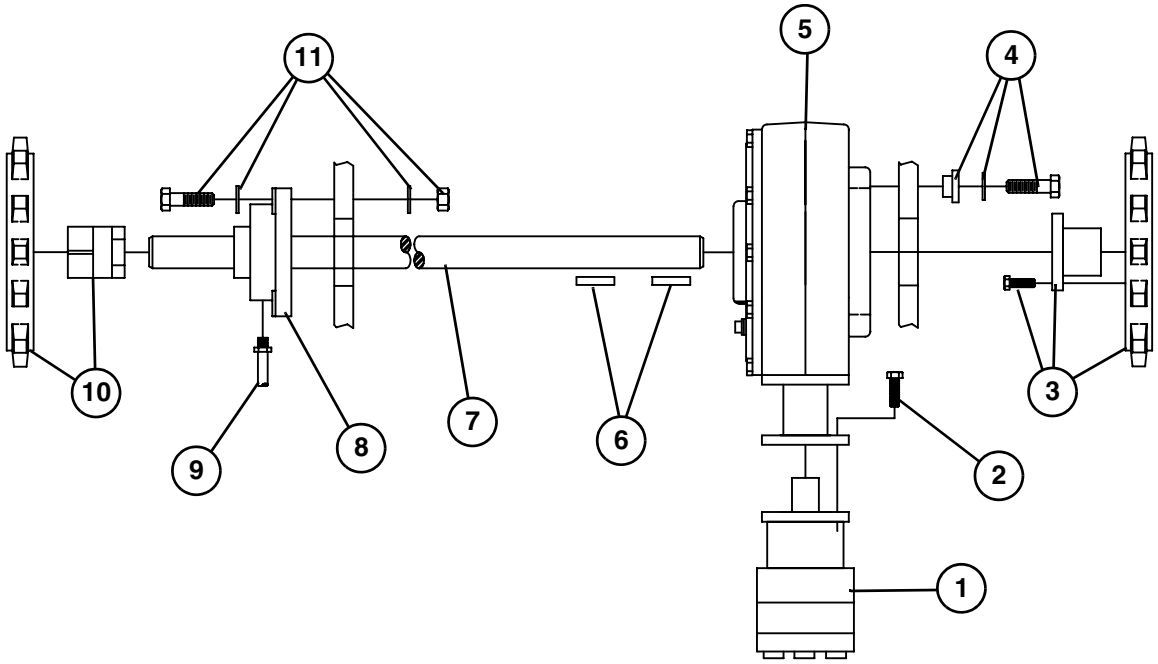
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Install

Reverse removal procedure to install new bearings.

- Apply a film of copper base anti-seize lubricant (P/N 602695583) to ends of paddle wheel shaft before installing new bearings.
- Torque all bolts according to standard torque charts.

Conveyor Shift Gearbox and Bearing



Remove

To remove gearbox:

NOTE: For easier removal of the gearbox, refer to instructions on page **9C-9** and remove complete conveyor assembly.

1. Follow *"Shutdown Procedure," page* **2-1**.
2. Label and remove hoses from shift motor **(1)**. Plug hoses and cap fittings.
3. Remove bolts **(2)** securing motor to gearbox. Remove motor.
4. Disconnect remote lubrication hose **(9)** from bearing **(8)**. Plug hose and cap fitting.

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5. Remove bolts, washers and bushings **(4)** securing gearbox to main frame.
6. Remove bolts, washers, and nuts **(11)** securing bearing to main frame.
7. Remove complete assembly from machine.
8. Remove bolts, hub, and sprocket **(3)** from shaft. Retain keys **(6)**.
9. Remove bushing and sprocket **(10)**.
10. If replacing bearing **(8)**, slide off shaft.
11. If replacing gearbox **(5)**, slide off shaft.

Install

Reverse removal procedure to install.

- Torque all bolts according to standard torque tables.

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Chapter 10—Auxiliary Subsystem

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Section C: Repair

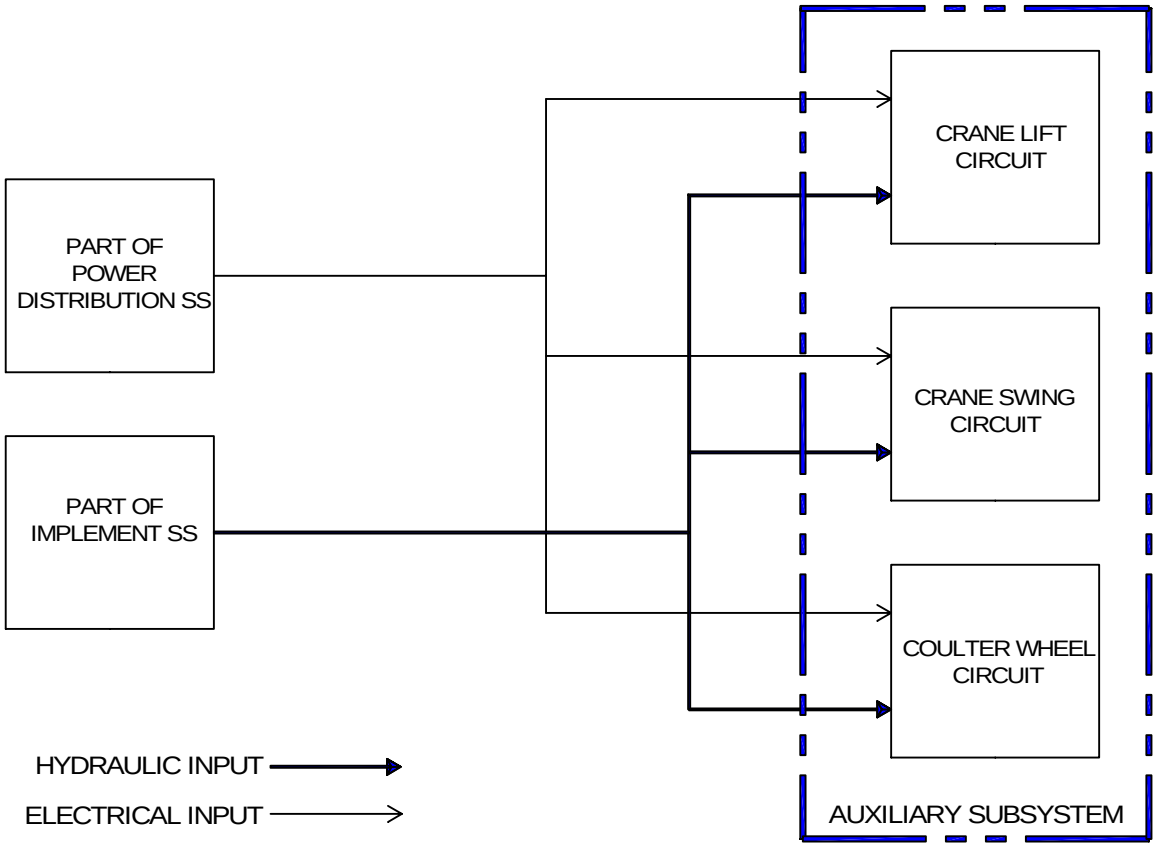
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Chapter 10: Auxiliary Subsystem

Section A: Theory

OVERVIEW

MAP



Lines and arrows on the MAP illustrate the interdependencies of the subsystems. The Power Distribution and Implement subsystems supply the electrical and hydraulic input necessary for operation.

Some machines are equipped with an optional Load/Return conveyor subsystem that works in conjunction with the Auxiliary subsystem. The Auxiliary subsystem consists of the circuits and components necessary for controlling optional crane lift and swing, as well as optional coulter wheel operation. All three hydraulic circuits are plumbed into and utilize flow, pressure, and return from the Implement subsystem.

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Circuits/Components

The following circuits and components are used in the Auxiliary subsystem.

Coulter Wheel Circuit:

Part of Control Valve Assembly A10DC1
Coulter Wheel Cylinder CY15
Coulter Wheel Control Switch S20

Crane Swing Circuit:

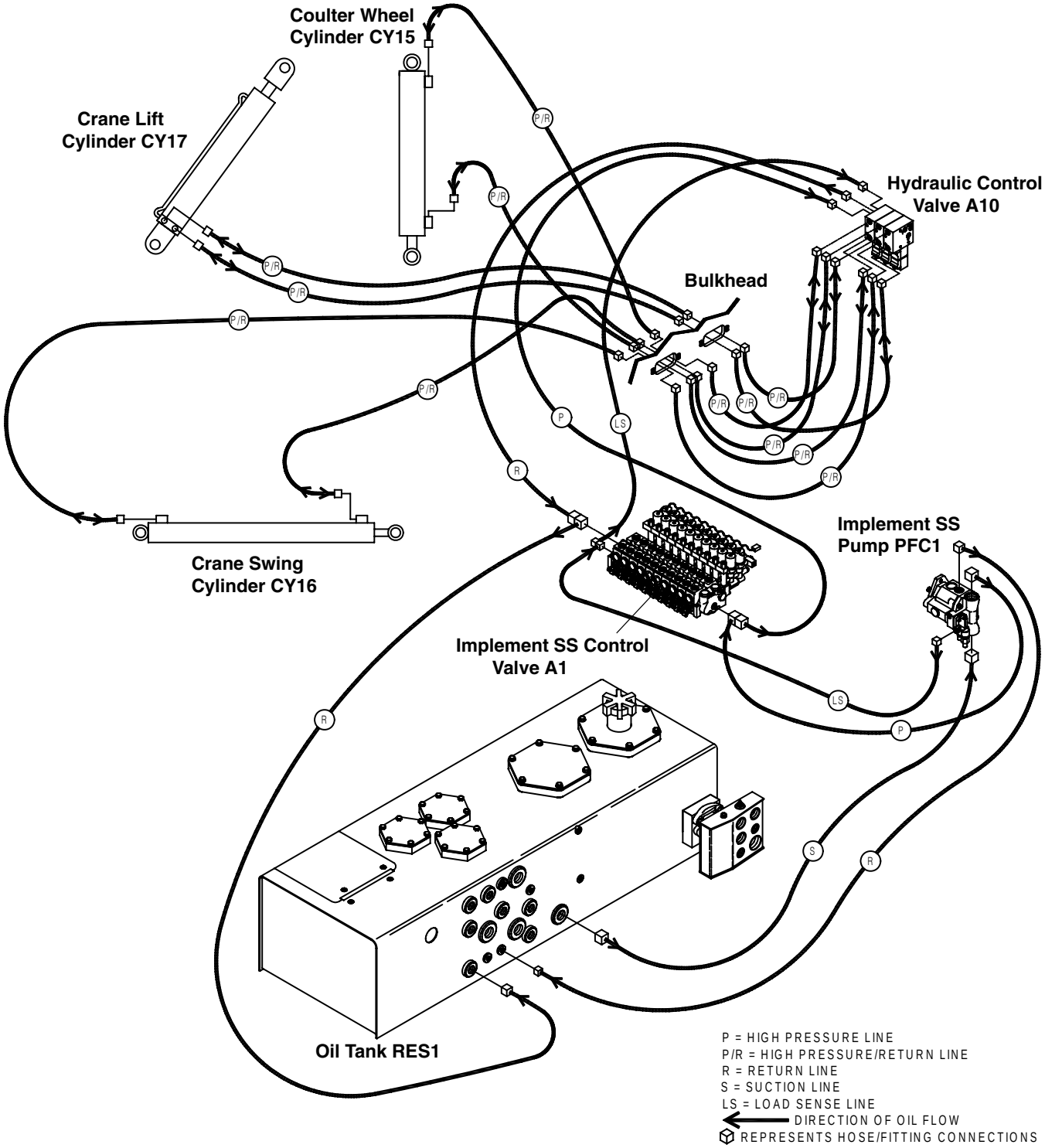
Part of Control Valve Assembly A10DC2
Crane Swing Cylinder CY16
Crane Swing Control Switch S18

Crane Lift Circuit:

Part of Control Valve Assembly A10DC3
Crane Lift Cylinder CY17
Crane Lift Control Switch S19

Hydraulic Hose Connections

Note: Orientation of components does not reflect actual machine configuration.



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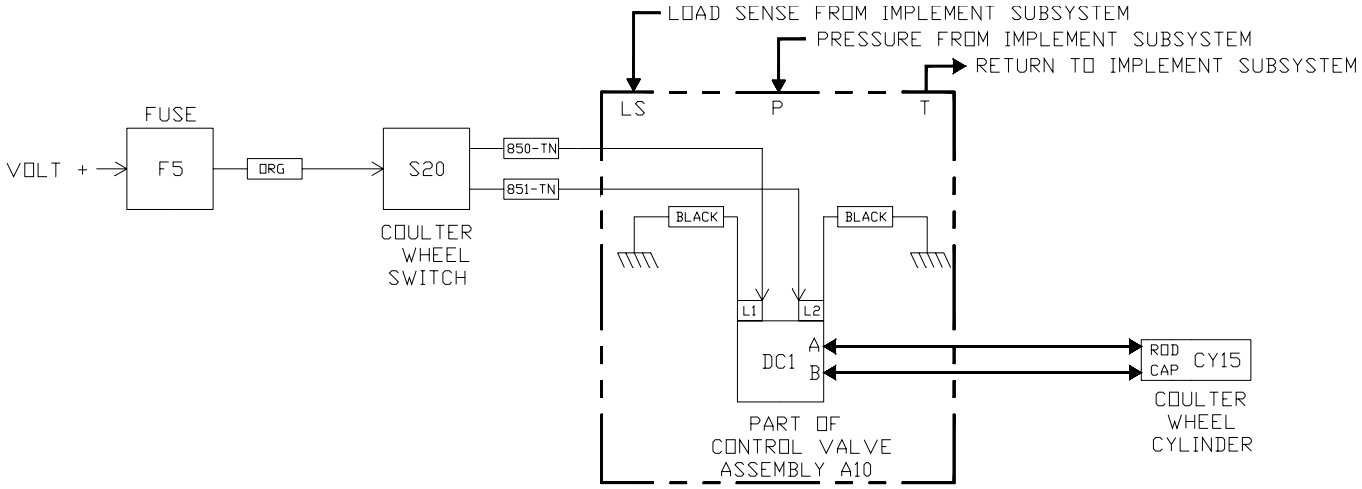
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Implement Subsystem Pressure-Flow Standby

When the hydraulic system is not actuated, the Implement subsystem pressure-flow compensated piston pump will remain in the low pressure standby mode at only 400 psi (27.5 bar). When a function is actuated, the piston pump senses the demand for flow and adjusts the pump displacement to increase the flow required at only the pressure required to operate the circuit, plus the 400 psi (27.5 bar) to operate the compensator.

The pump will strive to maintain the flow required, under all working conditions of the system. Load-sensing lines connecting both subsystem control valves, feed all the circuit requirements to the pump compensator. Refer to the Implement subsystem “Pressure-Flow Standby Circuit,” page 6A-10 for detailed operating information on the pump.

COULTER WHEEL CIRCUIT



Operation

The control valve assembly receives pressurized oil flow from the Implement subsystem control valve and hydraulic pressure-flow compensated pump. Refer to “Implement Subsystem Pressure-Flow Standby,” page 10A-4 for information.

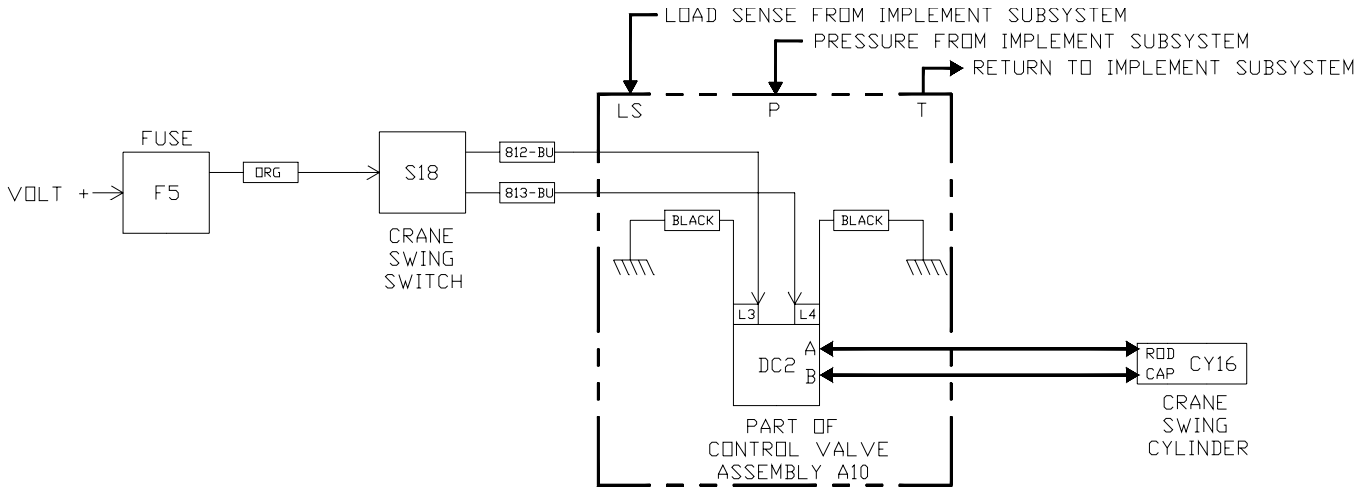
Cylinder - Extend (Lower)

When pushing the coulter wheel control switch S20 down, a voltage path is complete to energize solenoid L2 of directional control valve DC1. The valve spool will shift, directing oil through B port of valve section DC1 to cap (base) end of cylinder CY15.

Cylinder - Retract (Raise)

When pushing the coulter wheel control switch S20 up, a voltage path is complete to energize solenoid L1 of directional control valve DC1. The valve spool will shift, directing oil through A port of valve section DC1 to rod end of cylinder CY15.

CRANE SWING CIRCUIT



Operation

The control valve assembly receives pressurized oil flow from the Implement subsystem control valve and hydraulic pressure-flow compensated pump. Refer to “Implement Subsystem Pressure-Flow Standby,” page **10A-4** for information.

Cylinder - Extend (Swing Crane Right)

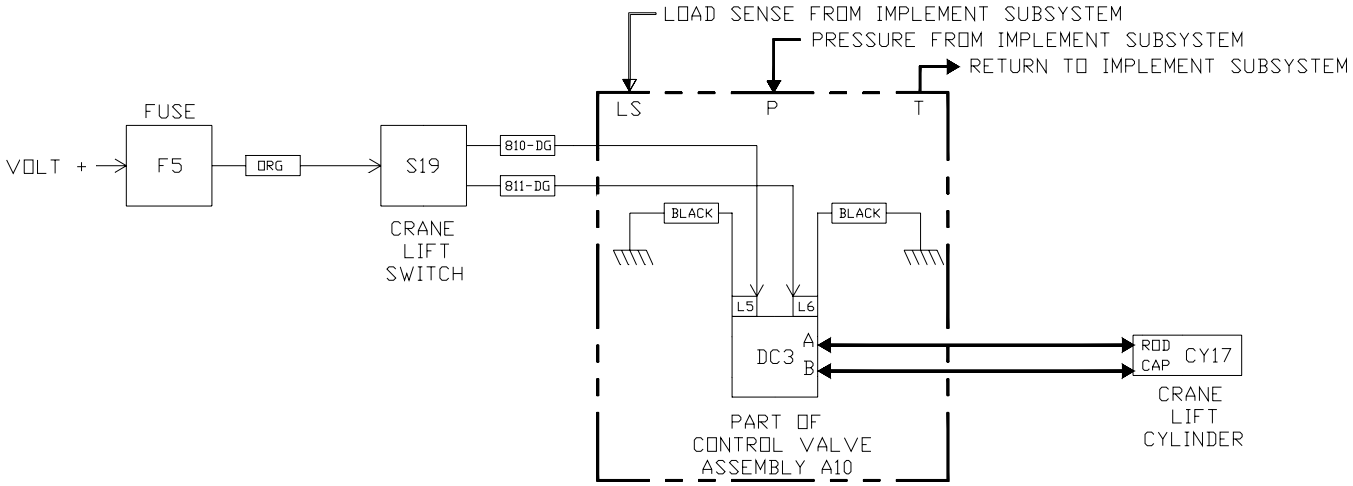
When pushing the crane swing control switch S18 down, a voltage path is complete to energize solenoid L4 of directional control valve DC2. The valve spool will shift, directing oil through B port of valve section DC2 to cap (base) end of cylinder CY16.

Cylinder - Retract (Swing Crane Left)

When pushing the crane swing control switch S18 up, a voltage path is complete to energize solenoid L3 of directional control valve DC2. The valve spool will shift, directing oil through A port of valve section DC2 to rod end of cylinder CY16.

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CRANE LIFT CIRCUIT



Operation

The control valve assembly receives pressurized oil flow from the Implement subsystem control valve and hydraulic pressure-flow compensated pump. Refer to “Implement Subsystem Pressure-Flow Standby,” page 10A-4 for information.

Cylinder - Extend (Lower)

When pushing the crane lift control switch S19 down, a voltage path is complete to energize solenoid L6 of directional control valve DC3. The valve spool will shift, directing oil through B port of valve section DC3 to cap (base) end of cylinder CY17.

Cylinder - Retract (Raise)

When pushing the crane lift control switch S19 up, a voltage path is complete to energize solenoid L5 of directional control valve DC3. The valve spool will shift, directing oil through A port of valve section DC3 to rod end of cylinder CY17.

Chapter 10: Auxiliary Subsystem

Section B: Troubleshooting

OVERVIEW



WARNING: Pressurized fluid can penetrate body tissue and result in serious injury or death. Leaks can be invisible. Keep away from any suspected leak. Relieve pressure in the hydraulic system before searching for leaks, disconnecting hoses, or performing any other work on the system. If you must pressurize the system to find a suspected leak, use an object such as a piece of wood or cardboard rather than your hands. When loosening a fitting where some residual pressure may exist, slowly loosen the fitting until oil begins to leak. Wait for leaking to stop before disconnecting the fitting. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

Pretest Inspection

Before beginning any troubleshooting, review information in the General Information Chapter under “Troubleshooting Guidelines,” page 1-9.

If a malfunction occurs, do the following visual checks to inspect for obvious signs of failures before any testing is performed.

- Check for any obvious mechanical failures such as, broken linkages, cables, sprockets, chains, sheaves, pulleys, belts, and so on.
- Check hydraulic oil level in tank, especially if other subsystem/circuits are experiencing similar performance problems.
- Check hydraulic circuits for any obvious failures such as, broken, kinked, loose, or leaking motor or pump shaft seals, leaking hoses and fittings on supply, pressure, and return to hydraulic components. Also, check for broken, missing, corroded, or loose connections and wires that supply ground and power to electrical components.

Fault Chart

If no problems were found during the pretest inspection, refer to the fault chart on page 10B-3 and continue troubleshooting. The possible malfunctions listed do not cover everything that could go wrong with the circuits. They are meant to give a technician a logical place to begin, based on performance observations.

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Test Equipment Needed

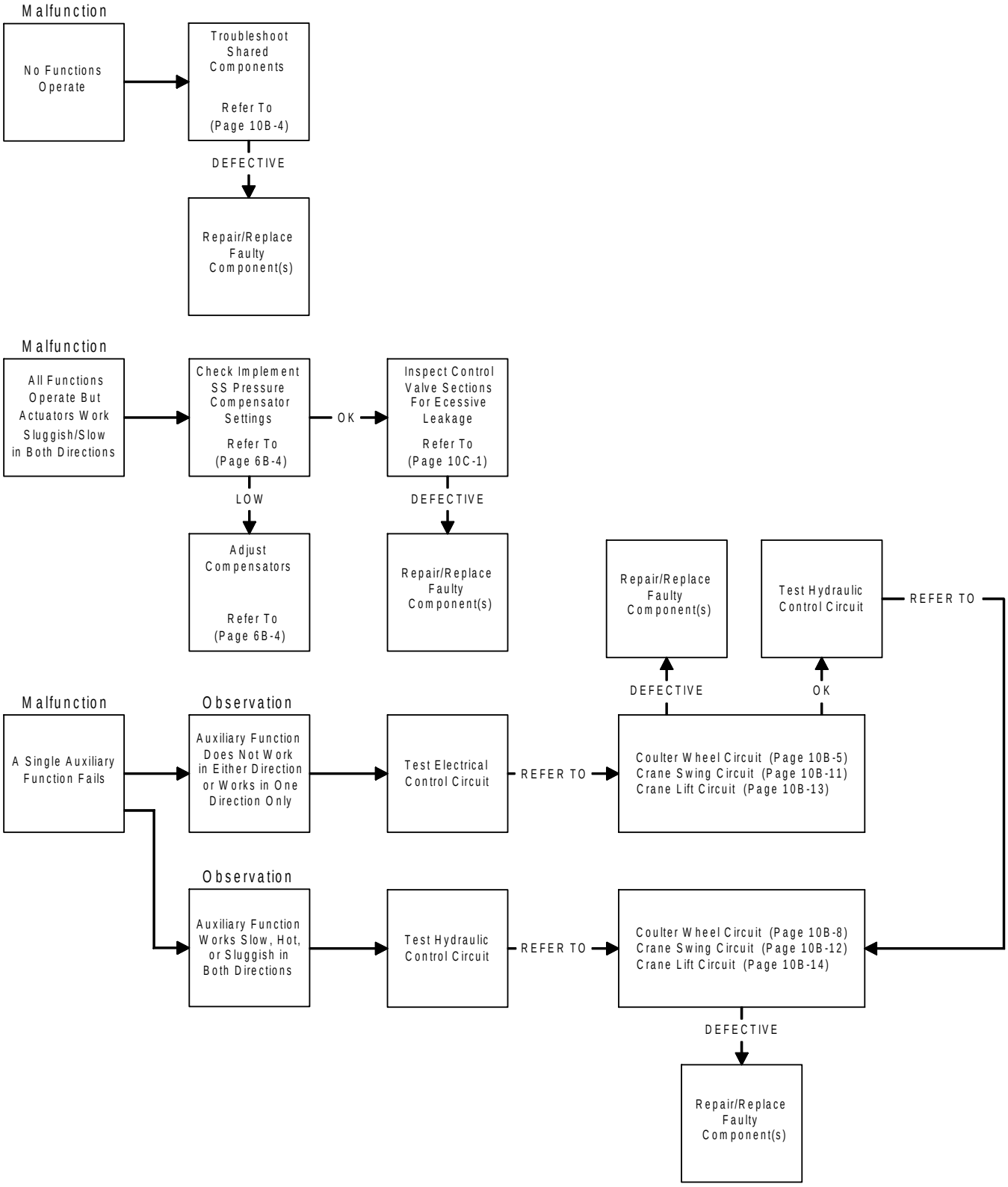
IMPORTANT: The pressure and flow ratings of the test equipment used to conduct the following hydraulic test procedures must be equal to, or greater than the pressure and flow ratings of the circuit being tested.

- Pressure Gauge
- Flow Meter
- Pyrometer
- Digital Multimeter

Component Repair/Replace

If troubleshooting procedures determine a component is in need of repair or replacement, refer to section C for the appropriate repair procedures for those components.

FAULT CHART


Malfunction
No Functions Operate
Troubleshoot Shared Components
Refer To (Page 10B-4)
DEFECTIVE
Repair/Replace Faulty Component(s)
Malfunction
All Functions Operate But Actuators Work Sluggish/Slow in Both Directions
Check Implement SS Pressure Compensator Settings
Refer To (Page 6B-4)
OK
Inspect Control Valve Sections For Ecessive Leakage
Refer To (Page 10C-1)
LOW
DEFECTIVE
Adjust Compensators
Refer To (Page 6B-4)
Repair/Replace Faulty Component(s)
Repair/Replace Faulty Component(s)
Test Hydraulic Control Circuit
REFER TO
DEFECTIVE
OK
Malfunction
A Single Auxiliary Function Fails
Observation
Auxiliary Function Does Not Work in Either Direction or Works in One Direction Only
Test Electrical Control Circuit
REFER TO
Coulter Wheel Circuit (Page 10B-5)
Crane Swing Circuit (Page 10B-11)
Crane Lift Circuit (Page 10B-13)
Observation
Auxiliary Function Works Slow, Hot, or Sluggish in Both Directions
Test Hydraulic Control Circuit
REFER TO
Coulter Wheel Circuit (Page 10B-8)
Crane Swing Circuit (Page 10B-12)
Crane Lift Circuit (Page 10B-14)
DEFECTIVE
Repair/Replace Faulty Component(s)

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SHARED COMPONENT TROUBLESHOOTING

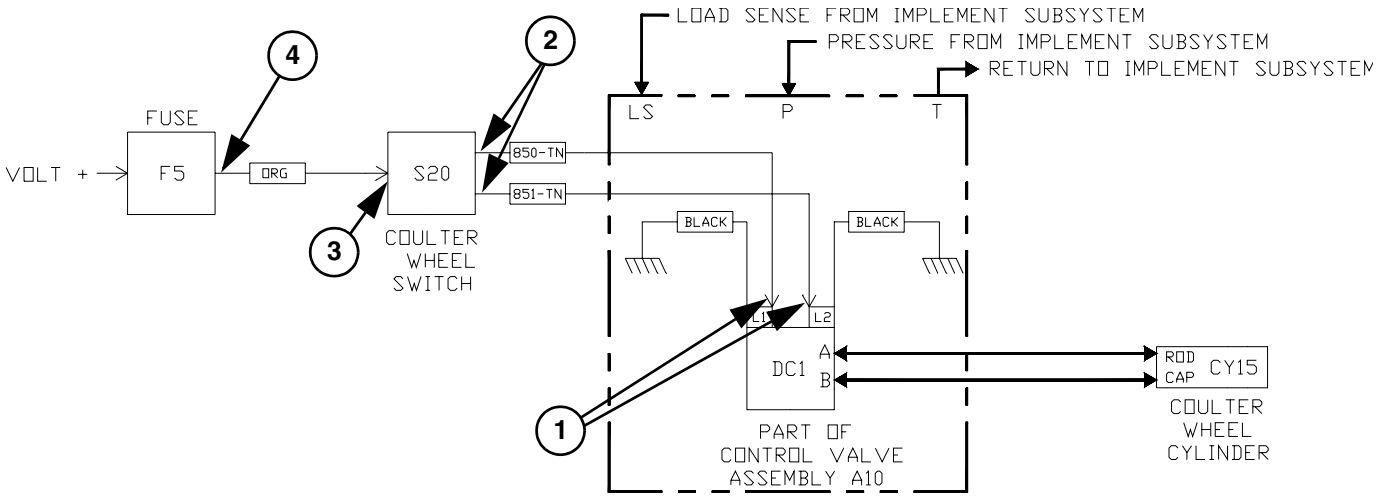
The auxiliary circuits as well as some of the implement circuits share a common fuse. The auxiliary circuits utilize flow, pressure, and load sense from the Implement subsystem. These components should be investigated.

1. If there are no auxiliary functions operating, check the implement circuits sharing the fuse for operation. If these circuits function, go to step 3. If not, continue with step 2.
2. Check fuse F5. If the fuse is blown, replace it. If the fuse continues to blow, there is most likely a short in either one of the implement or auxiliary circuits. Test each circuit until the short is found. Refer to page **10B-7** for information on testing. Repair or replace faulty component or section of wire harness.
3. Refer to the Implement subsystem page **6B-9** and check pressure compensator settings. If pressures are incorrect, adjust the compensators. If settings are correct, inspect the load sense and pressure lines from the implement control valve assembly.

COULTER WHEEL CIRCUIT

Electrical Troubleshooting

The following procedures are used to test for opens, shorts or high resistance in the circuit. Begin testing the circuit for acceptable voltage. Refer to open circuit test page **10B-7**.

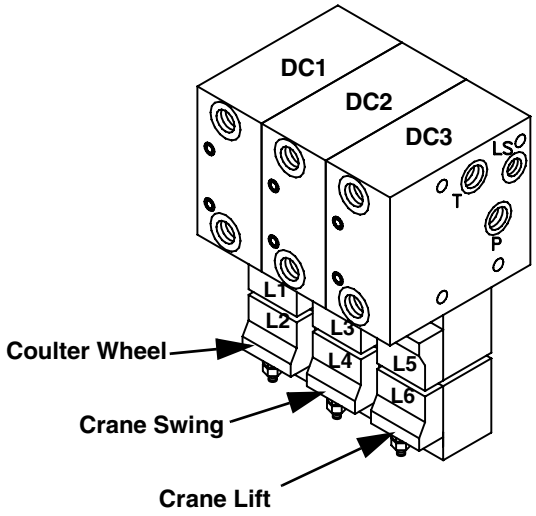


Testing Sequence

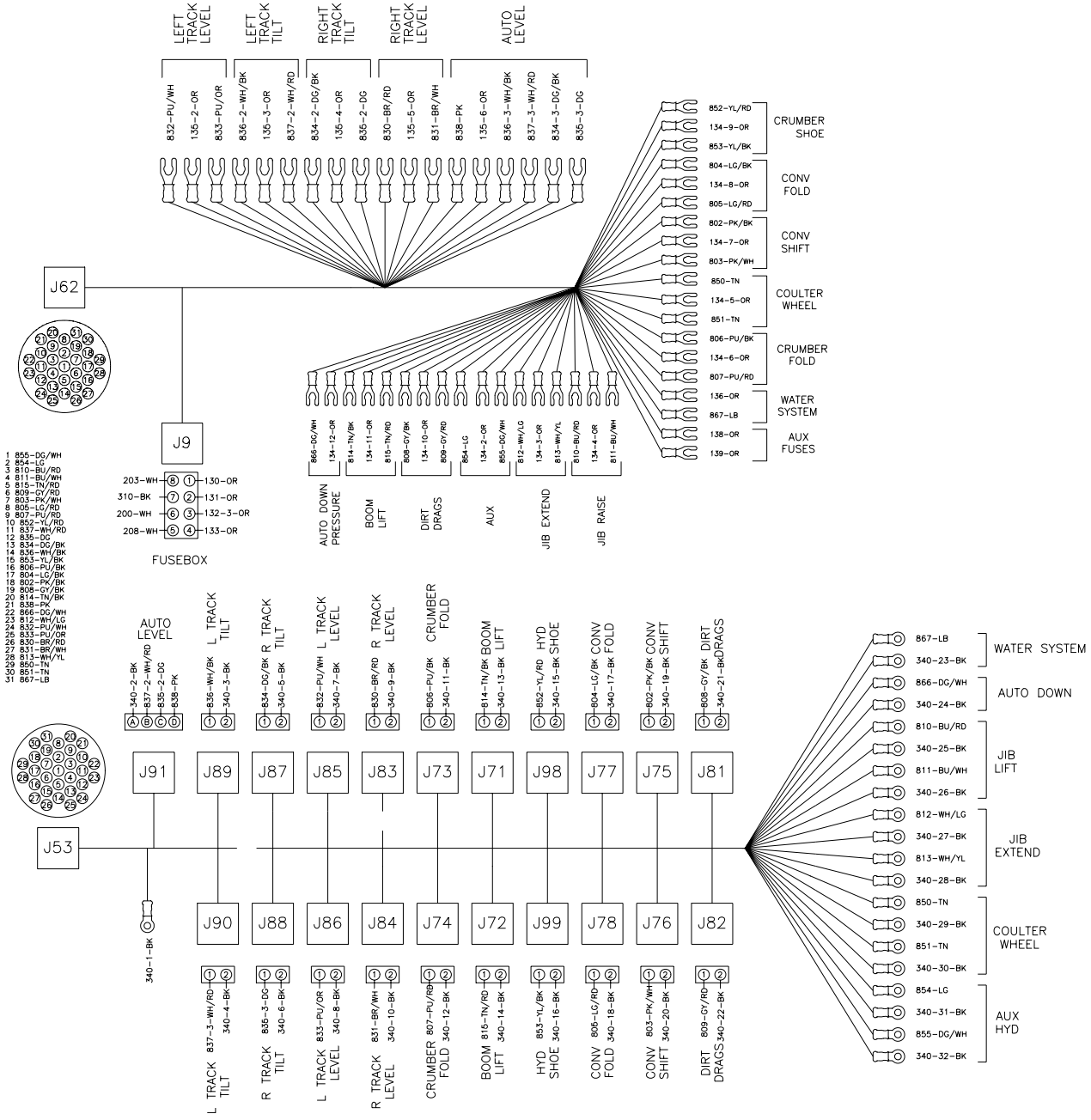
The testing sequence gives a troubleshooter a logical place to begin troubleshooting the electrical circuit. The sequence test points start at the load **(1)** and work back through the complete circuit **(4)**.

Control Valve Reference

Refer to the graphic on the right and wire harness diagram on the following page for solenoid, plug, and component terminal/pin reference. If necessary, refer to the addendum section in the rear of the manual for complete electrical schematic.



Component Pin/ Terminal Reference



The diagram above represents the wire harness connections of the implement circuits/components. Use diagram for pin, terminal, wire, and plug reference when testing circuits and components. Only the wire harness connections relevant to the implement control circuits are represented.

Refer to the Addendum located in the rear of the manual for a complete wire harness diagram and electrical schematic if needed.

Continued on next page...

Open Circuit Test

1. Test for an open in the circuit by testing acceptable voltage on power input and output pins/terminals of plugs and components at test points shown on circuit diagram. Testing at these points, starting at the load **(1)** and working through the circuit will isolate the failed component by process of elimination. Continue through the steps until the open is found.

   Expected result: When the positive lead is placed before an open point, the meter will read full battery voltage. When the lead is placed beyond the open, the meter will read no voltage, indicating that a complete circuit exists from the chassis ground to the point where voltage is last seen in the circuit.

   If battery voltage is measured at the valve solenoids **(1)**, unplug wire harness at the solenoid and check coil for resistance.

   Expected result: The resistance should measure 8 ± .8 Ω If not, replace the solenoid coil.

2. Once the open is found, turn ignition switch OFF, unplug wire harness at the suspected component and test component for continuity. If the component is OK, test wires connecting the component for continuity. Replace faulty component or section of wire harness. If battery voltage is measured at points, continue next by measuring for voltage on ground side.

3. Normal voltage should measure 0.0–0.5 volts. If battery voltage is measured on ground side, a poor connection or broken wire/cable is indicated. Test wires connecting the component for continuity. Replace faulty section of wire harness.

High Resistance Test

Measurements taken from a multimeter can be used to troubleshoot for unwanted resistance. Use the multimeter to test for lower than normal battery voltage (voltage drop) while moving to accessible points in the circuit wiring. Replace section of failed wire harness. Refer to the diagram on page 10B-5.

Short Circuit Test

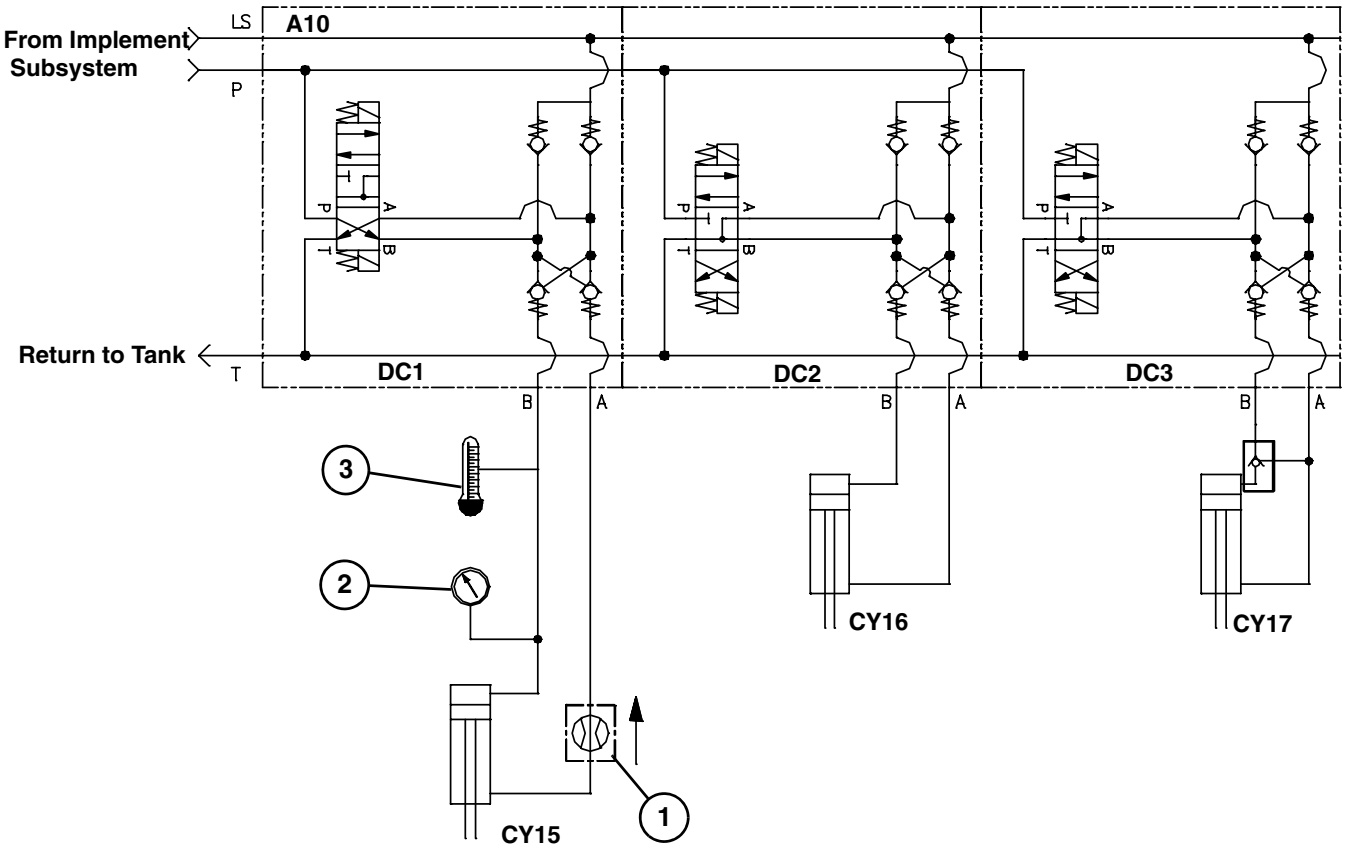
1. Test for a short in the circuit. When testing the circuit for a short, turn ignition switch OFF and set the multimeter to measure resistance (ohms). Work through the circuit, if the meter measures resistance through the complete circuit, it may be an intermittent problem causing the short. In that case, repeat procedure and move wiring harness or tap on components while watching for a sudden drop in resistance Ω

   Expected result: If the voltage side of the circuit is shorted to ground, the meter will read 0.0Ω This indicates there is no resistance between check points (a dead short). Work through the circuit until the short is located. When the short is removed, the meter will return to a resistance reading.

2. Repair or replace faulty component or section of wire harness. Check circuit for function.

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Hydraulic Troubleshooting



The cylinder in the circuit performs the actual work and is most likely to be the component that fails in the circuit. Typical failures would include bending, breaking, or a leaking rod wiper seal. If an obvious problem is not found, the cylinders should be tested for excessive leakage.

Cylinder Test Procedure

The coulter wheel circuit has a counterbalance valve cartridge installed in the cylinder. If the cylinder will work in one direction only, it is possible that the cartridge may be faulty. If suspected, refer to repair section and inspect, repair, or replace valves per instructions given.

Ensure any hoses or fittings that are added to the test equipment are the same size and rating as hoses and fittings installed in the hydraulic circuit. Mismatched hose or fitting sizes can result in erroneous pressure indications. Mismatched pressure ratings can result in leakage or personal injury.

The illustrations depicts the cylinder being tested in the rod extend position. Damage to the test equipment can occur if it is not installed correctly. Note direction of the arrow on the flow meter when installing.

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The following test will determine if cylinders are leaking beyond design specification. When testing the rod retract position, install flow meter and pressure gauge to the opposite cylinder ports. The test procedure will be the same.

1. Shut down engine.
2. Turn ground disconnect switch to DISABLE position.
3. Install flow meter **(1)** in series with connector of line feeding the rod end of cylinder.
4. Install pressure gauge **(2)** in parallel with the connector of line feeding the cap end of cylinder.
5. Make a photocopy of the cylinder test worksheet on page **10B-15**.
6. Turn ground disconnect switch to the ENABLE position. Start the engine and inspect test equipment connections for leaks.
7. Allow system to warm to approximately 130°F (54°C). Observe pyrometer **(3)**.
8. Actuate directional control valve to the rod extend position.

   Expected result: When rod reaches the end of its stroke, the pressure in the cap end of cylinder should increase to the value of the implement pump compensator setting, 2500 psi (172 bar). If the pressure is incorrect, refer to the Implement subsystem page **6B-9** and check pressure.
9. While holding the position (deadheading cylinder), record on test worksheet:

- Pressure indicated on pressure gauge **(2)**.
- Flow indicated on flow meter **(1)**.

10. Release directional control valve.
11. Shut down engine and analyze test results. Refer to page **10B-10**.
12. At conclusion of test procedure, remove test equipment, reconnect hydraulic lines, and tighten connections securely.
13. Start engine and check connections for leaks.

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Analyzing Cylinder Test Results

Diagnostic Observation 1:

- Pressure gauge **(2)** indicates pump compensator setting.
- Flow meter **(1)** indicates zero to marginal flow.

Diagnosis - Leakage across the piston appears to be within design specification. The cylinder is not the problem.

Diagnostic Observation 2:

- Pressure gauge **(2)** indicates pump compensator setting.
- Flow meter **(1)** indicates moderate to high flow.

Diagnosis - Leakage across the piston appears to be excessive. Repair or replace cylinder.

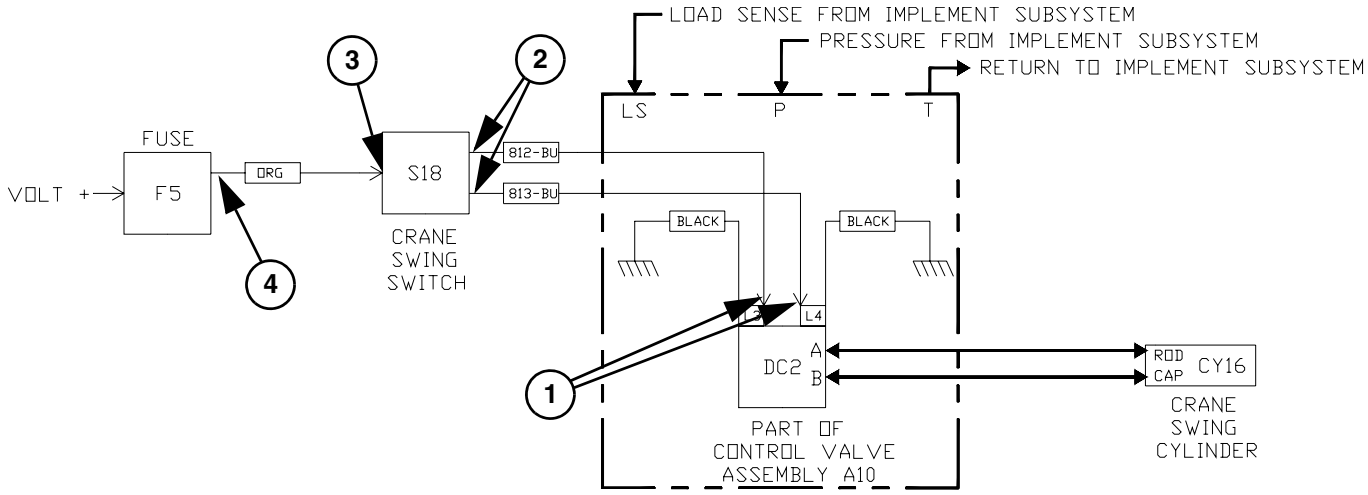
Diagnostic Observation 3:

- Pressure gauge **(2)** indicates a pressure somewhat less than pump compensator setting.
- Flow meter **(1)** indicates high flow.

Diagnosis - Leakage across the piston is excessive. Repair or replace cylinder.

CRANE SWING CIRCUIT

Electrical Troubleshooting



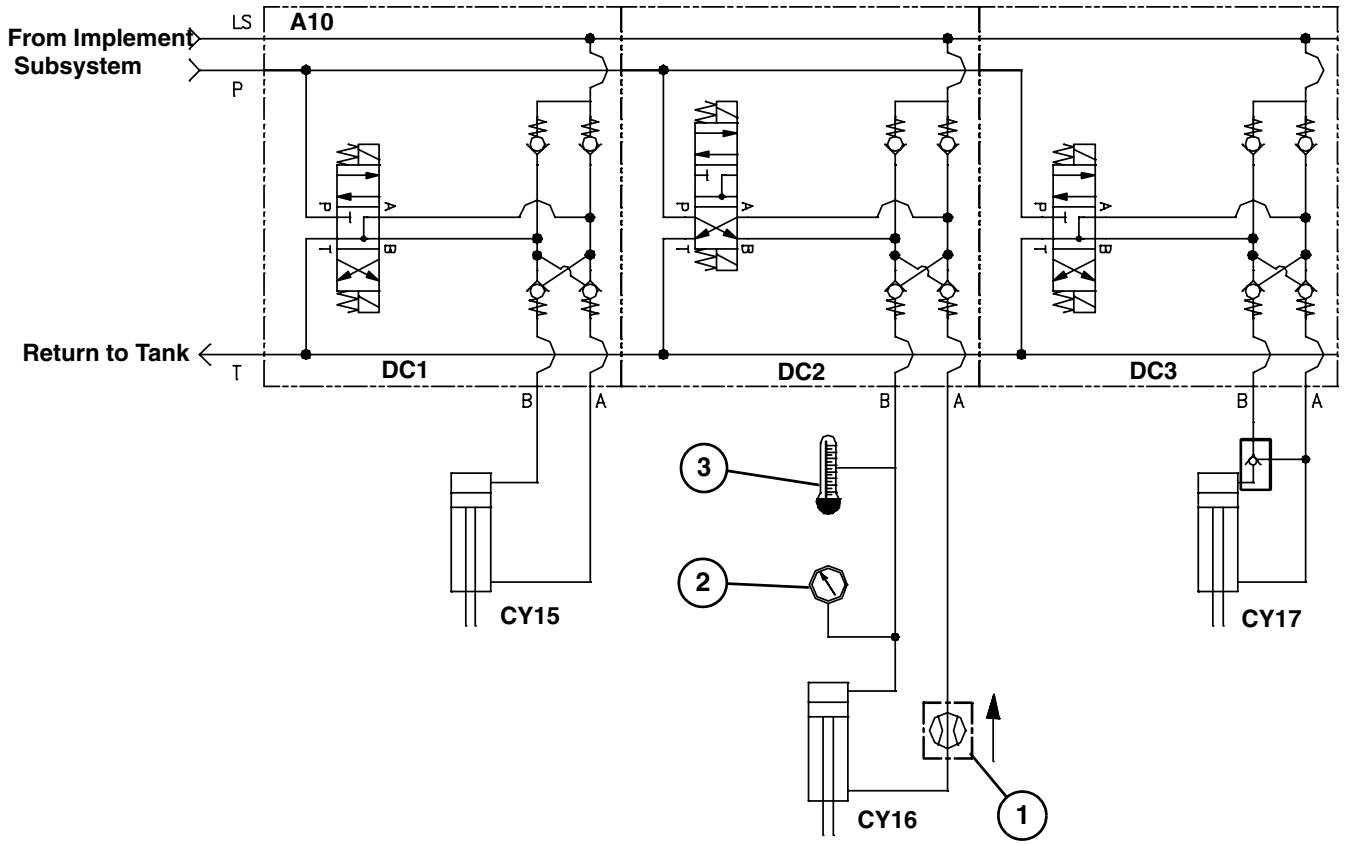
Refer to the electrical troubleshooting procedures for coulter wheel circuit on page 10B-5. The procedures for testing the crane swing function electrical circuits are the same.

Testing Sequence

The testing sequence gives a troubleshooter a logical place to begin troubleshooting the electrical circuits. The sequence test points start at the load **(1)** and work back through the complete circuit **(4)**.

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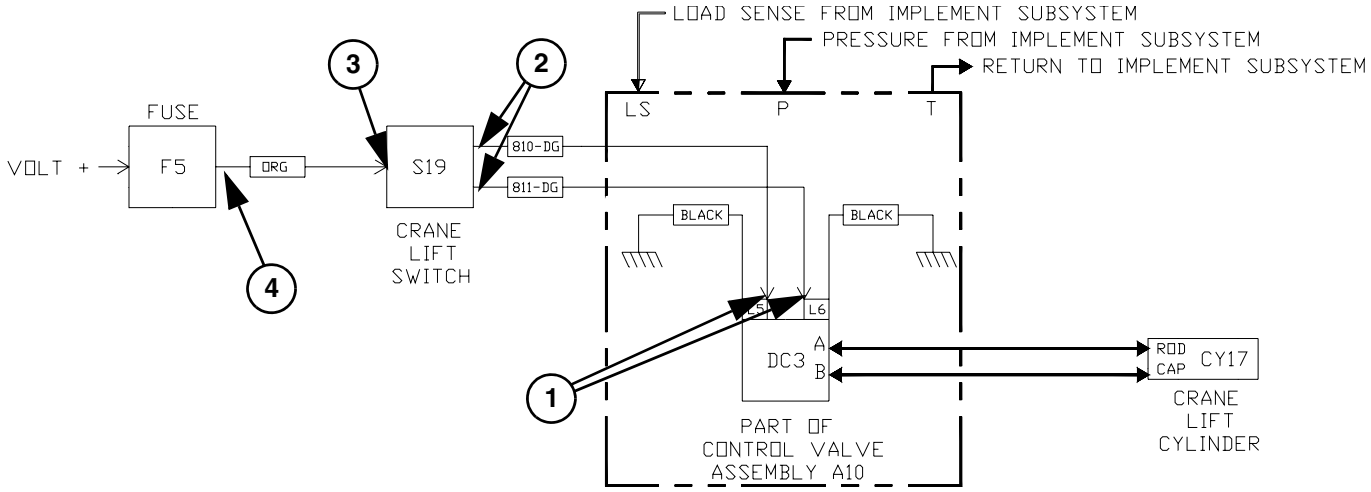
Hydraulic Troubleshooting



Refer to page **10B-8** and follow cylinder test procedures. Install the test equipment as shown in above diagram.

CRANE LIFT CIRCUIT

Electrical Troubleshooting



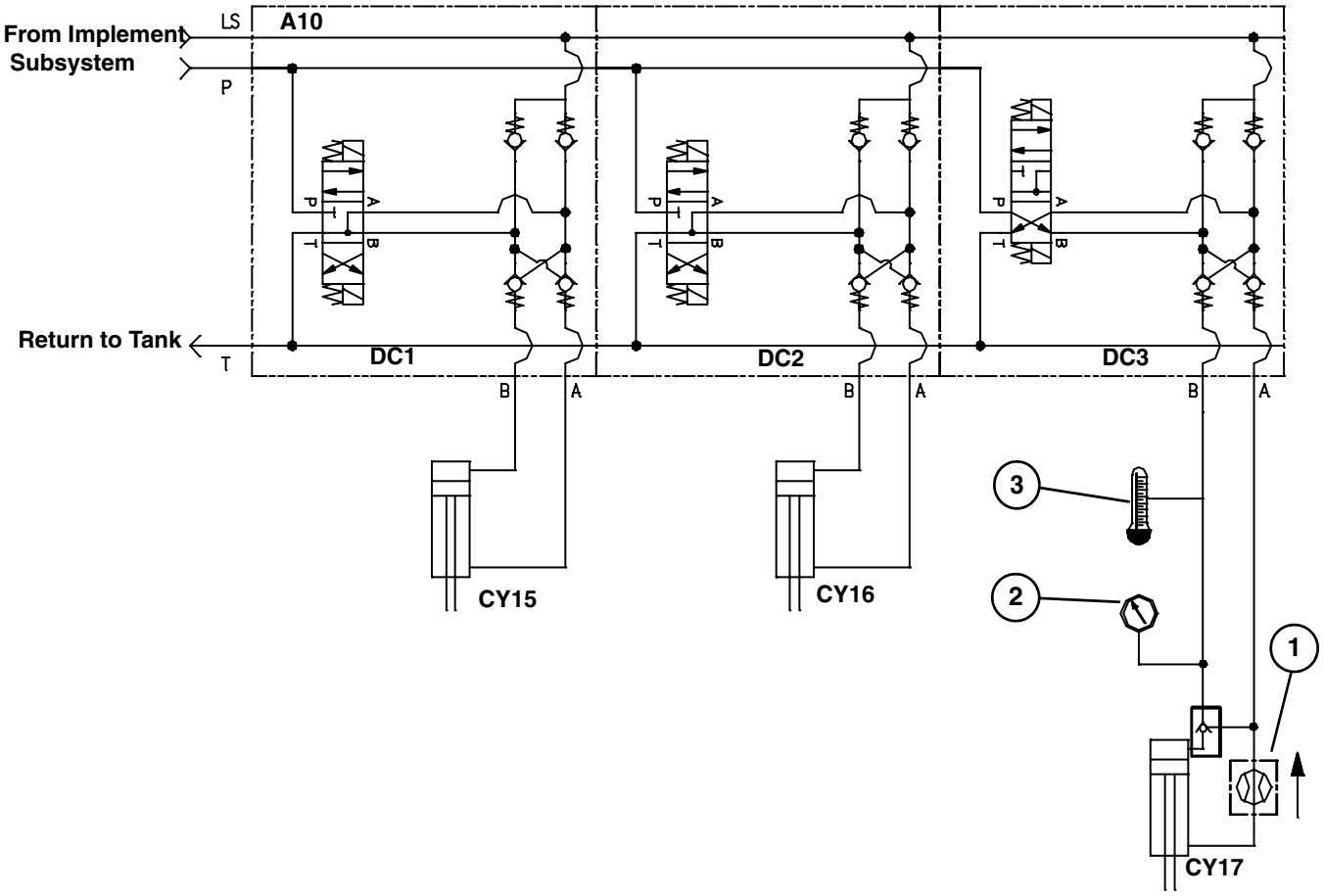
Refer to the electrical troubleshooting procedures for coulter wheel circuit on page 10B-5. The procedures for testing the crane lift function electrical circuits are the same.

Testing Sequence

The testing sequence gives a troubleshooter a logical place to begin troubleshooting the electrical circuits. The sequence test points start at the load **(1)** and work back through the complete circuit **(4)**.

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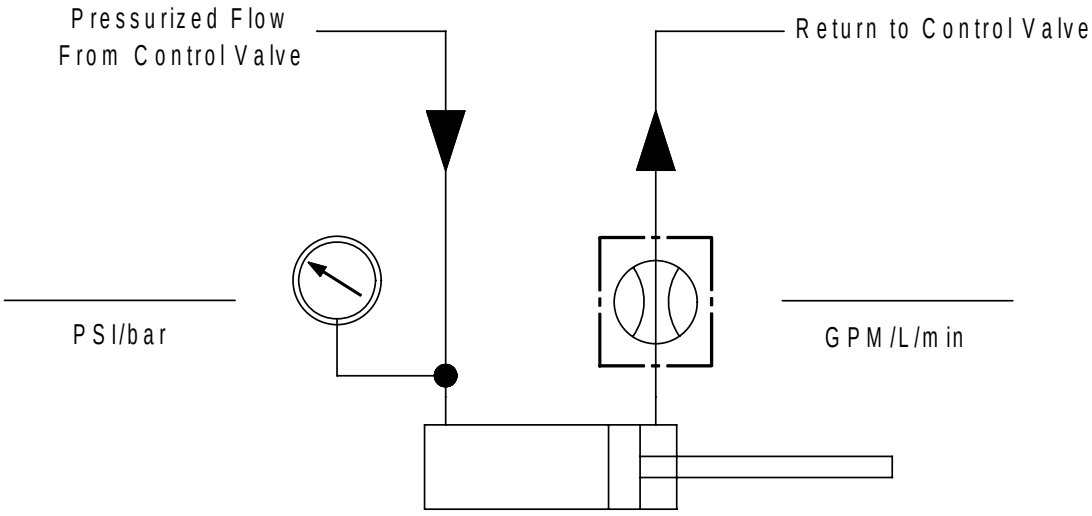
Hydraulic Troubleshooting



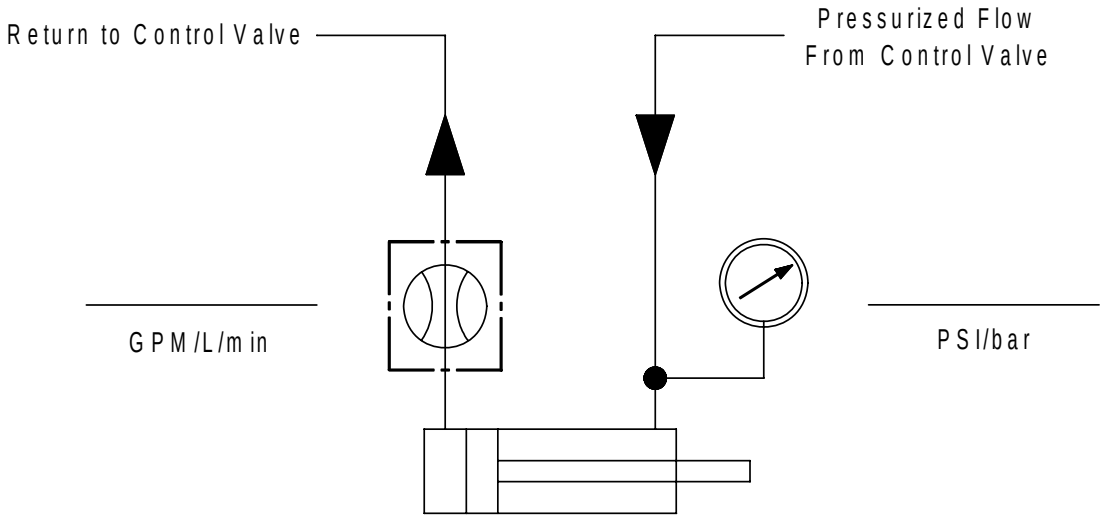
Refer to page **10B-8** and follow cylinder test procedures. Install the test equipment as shown in above diagram.

CYLINDER WORKSHEET

Cylinder Seal/Bore Deadhead Extend/Retract Test Procedure



(Extend)



(Retract)

°F/°C
Ambient Temp.

°F/°C
System Temp.

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Chapter 10: Auxiliary Subsystem

Section C Repair

INTRODUCTION

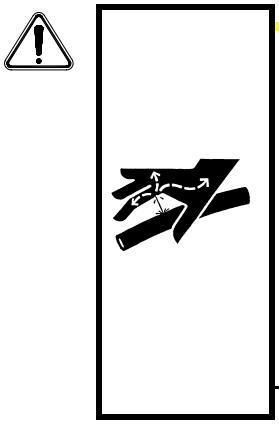
This section consists of repair procedures including the removal, replacement, installation, and repair of those hydraulic components responsible for operation of the auxiliary circuits.

Components

Hydraulic:

- Control Valve Assembly A10
- Cylinders CY15–CY17

HYDRAULIC REPAIR



WARNING: Pressurized fluid can penetrate body tissue and result in serious injury or death. Leaks can be invisible. Keep away from any suspected leak. Relieve pressure in the hydraulic system before searching for leaks, disconnecting hoses, or performing any other work on the system. If you must pressurize the system to find a suspected leak, use an object such as a piece of wood or cardboard rather than your hands. When loosening a fitting where some residual pressure may exist, slowly loosen the fitting until oil begins to leak. Wait for leaking to stop before disconnecting the fitting. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

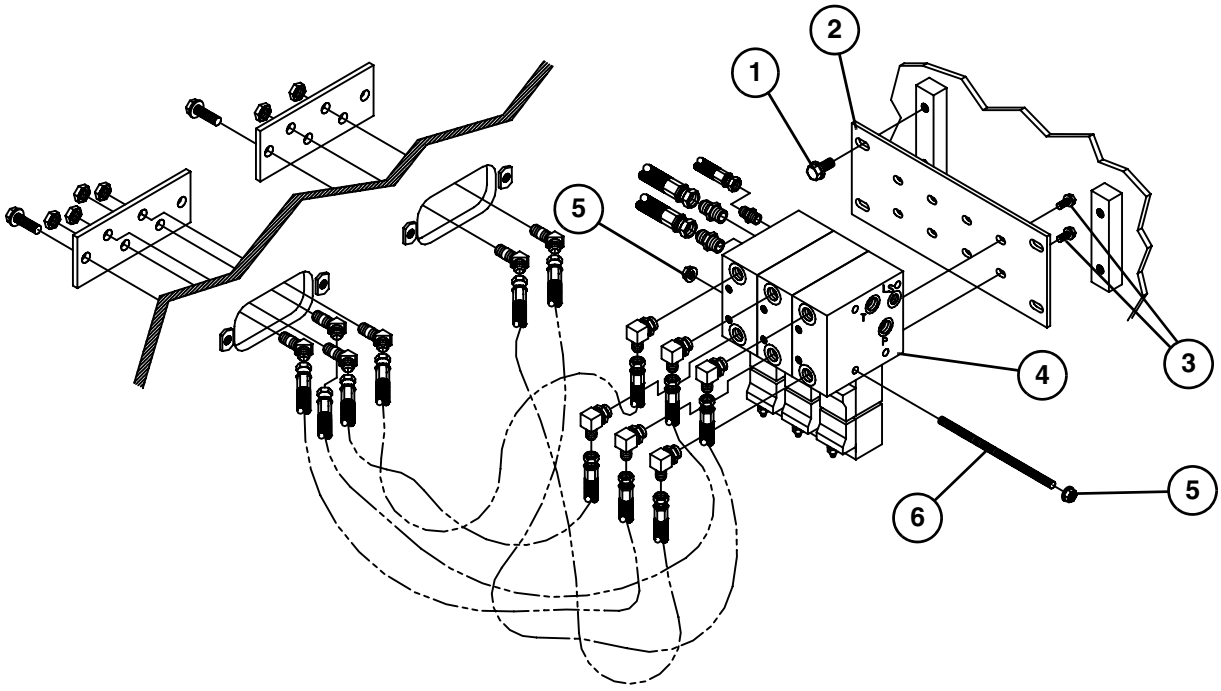
Cleanliness is extremely important when replacing or repairing hydraulic components. Work in a clean area. Before disconnecting hoses, thoroughly clean the port areas of pump, valve, cylinders and motors to be removed. Thoroughly clean outside of each component to be reinstalled.

Control Valve Assembly A10

Complete valve sections can be replaced or repaired with section seals and/or cartridge seal kits. The solenoid coils are also replaceable.

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Remove

To remove valve assembly to replace valve section or section seals:

1. Follow *"Shutdown Procedure," page* **2-1**.
2. Label and disconnect each hose from valve. Cap all fittings and plug all hoses.
3. Remove bolts **(1)** securing valve assembly and valve mount plate **(2)**. Remove valve assembly.
4. Remove bolts **(3)** securing valve assembly **(4)** to valve mount plate **(2)**.

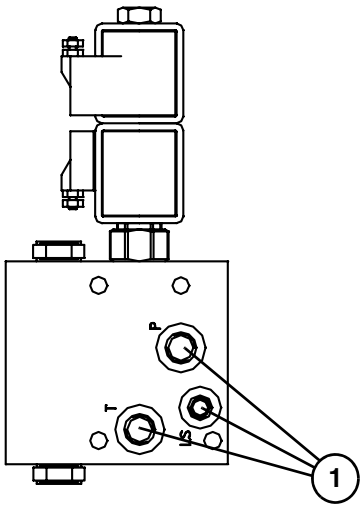
NOTE: Before disassembly, it is suggested that each valve section be marked numerically to avoid incorrect reassembly.

5. Remove stud kit nuts **(5)** connecting the valve sections together.
6. Remove valve sections by sliding from assembly studs **(6)**.

Continued on next page...

Section Seals - Replace

7. Remove old seals **(1)**. Thoroughly clean O-ring counterbores and surfaces of each section.
8. Install new seals in the order old ones were removed.
9. Replace valve sections on assembly studs in the same order they were removed. Use care to avoid dislodging O-rings from counterbores.
10. Reinstall stud and nuts and torque to 150 in-lb (17 Nm).



Install

Reverse control valve assembly removal procedure to install valve assembly to machine.

- Torque bolts **(1 & 3)** shown on previous page according to standard torque charts.

Solenoid and Check Valve Cartridges

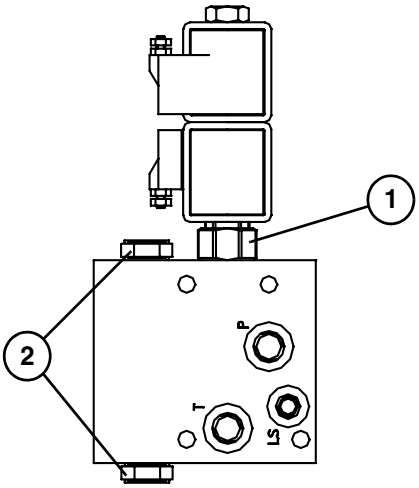
The solenoid cartridge valve **(1)** can be replaced as a complete unit or repaired by replacing seals or a solenoid coil if necessary.

The check valve cartridges **(2)** can also be replaced as a complete unit or repaired by replacing seals.

Seals - Replace

To replace seals:

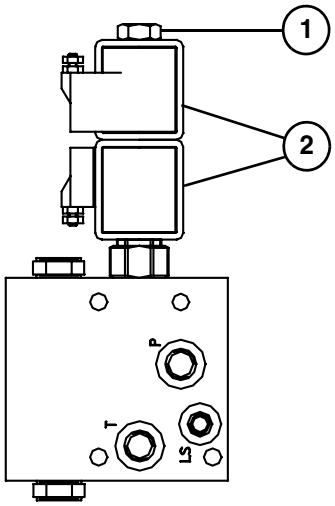
1. Remove cartridge to be repaired from the valve section.
2. Remove old seals.
3. Install new seals in order old ones were removed.
4. Dip cartridge in clean, filtered oil.
5. Screw cartridge in by hand until top O-ring is met.
6. Torque solenoid cartridge valve **(1)** to 50 ft-lb (68 Nm). Torque check valve cartridge valves **(2)** to 180 in-lb (20 Nm).



Solenoid Coil - Replace

To replace coil:

1. Remove nut **(1)**.
2. Slide coils **(2)** off spool.
3. Install new coil over spool. Ensure coil is correctly positioned as shown.
4. Torque nut **(1)** to 3 ft-lb (4.1 Nm).



Cylinders

If troubleshooting tests reveal cylinders are leaking, they can be removed and replaced as a complete unit or they can repaired. Repair kits are available for all of the cylinders.

Refer to page 6C-9 of the Implement subsystem repair for disassembly and repair procedures.

Cylinder Lock Valve

The crane lift function has an internal lock valve installed in the base end of the cylinder. This valve prevents the crane from dropping if a hose or fitting fails. The lock valve can be replaced as a complete unit or repaired by replacing seals.

NOTE: If a malfunction occurs in the circuit and a cylinder will only work in one direction, the lock valve should be investigated.



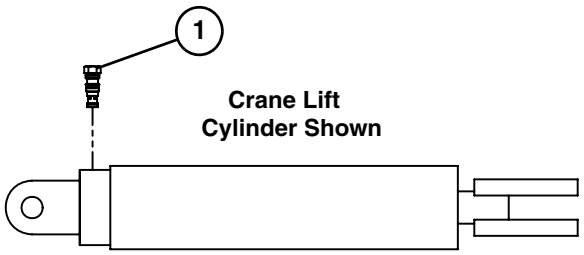


WARNING: Some residual pressure will probably remain in the cylinders equipped with lock valve cartridges in the base ends. Use extreme caution when removing a cartridge. The cartridge will be released with great force if residual pressure remains in the cylinder. Do not stand in front of the cartridge when removing it.

Continued on next page...

Remove

1. Follow *"Shutdown Procedure," page* **2-1**.
2. If a crane lift cannot be completely lowered, support it with a suitable lifting device so that it will not drop when cartridge is removed.



3. Relieve trapped pressure in cylinder by slowly loosening lock valve **(1)**.
4. Remove lock valve. Inspect seals. If damaged, replace. If seals are not damaged and the function could not be completely lowered, replace complete cartridge valve.

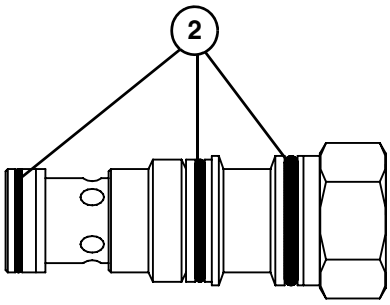
Install

5. Fill cylinder with clean filtered oil.
6. Dip cartridge in clean, filtered oil.
7. Screw cartridge in by hand until top O-ring is met.
8. Torque hex to 30–35 ft-lb (40–47 Nm).

Seals - Replace

To replace seals:

1. Remove old seals **(2)**. Note orientation of the backup washers and O-rings. This will ensure the new seals will be installed correctly.
2. Install new seals in order old ones were removed.
3. Inspect manifold cavity for burrs or other irregularities which could damage O-rings during installation.



4. Fill cylinder with clean filtered oil.
5. Dip cartridge in clean, filtered oil.
6. Screw cartridge in by hand until top O-ring is met.
7. Torque hex to 30–35 ft-lb (40–47 Nm).

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Chapter 11—Load/Return Conveyor Subsystem

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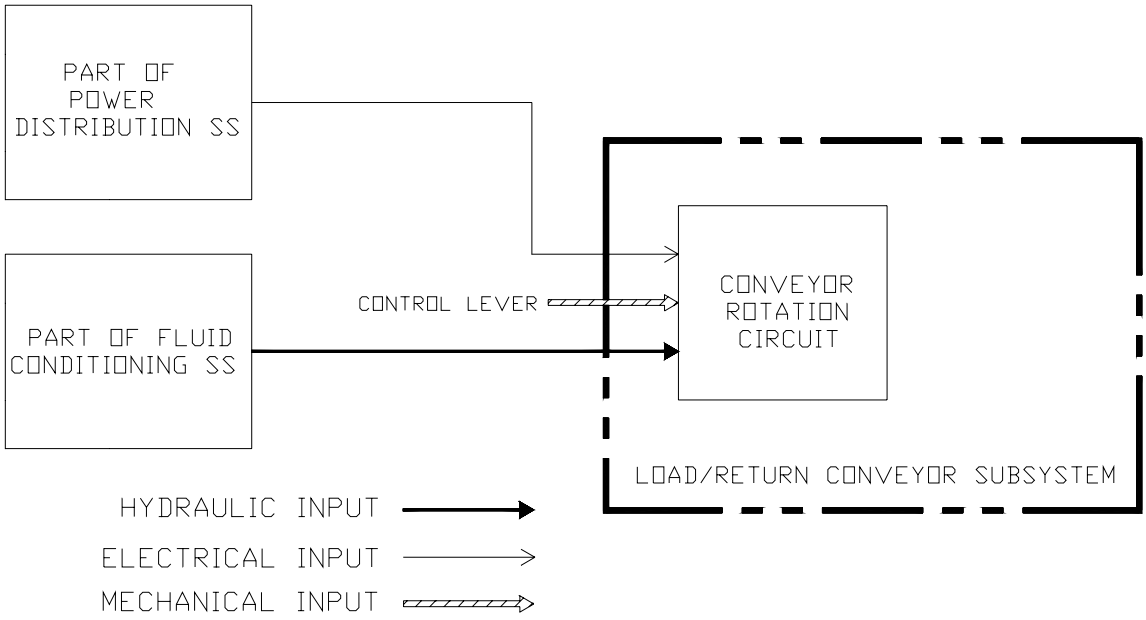
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Chapter 11: Load/Return Conveyor Subsystem

Section A: Theory

OVERVIEW



Lines and arrows on the MAP illustrate the interdependencies of the subsystems. The Power Distribution and Fluid Conditioning subsystems supply the electrical and hydraulic input and a lever controls the mechanical input necessary for operation.

Some machines are equipped with an optional Load/Return Conveyor subsystem. This subsystem works in conjunction with an optional Auxiliary subsystem that utilizes a crane for positioning the conveyor during operation.

The Auxiliary subsystem is considered independent from the Load/Return subsystem because of separate hydraulic control systems. Refer to “Overview,” page 10A-1 for more information on the Auxiliary subsystem.

The optional Load/Return Conveyor subsystem consists of the circuits and components necessary for controlling the conveyor rotation, speed, and trench spoil discharge.

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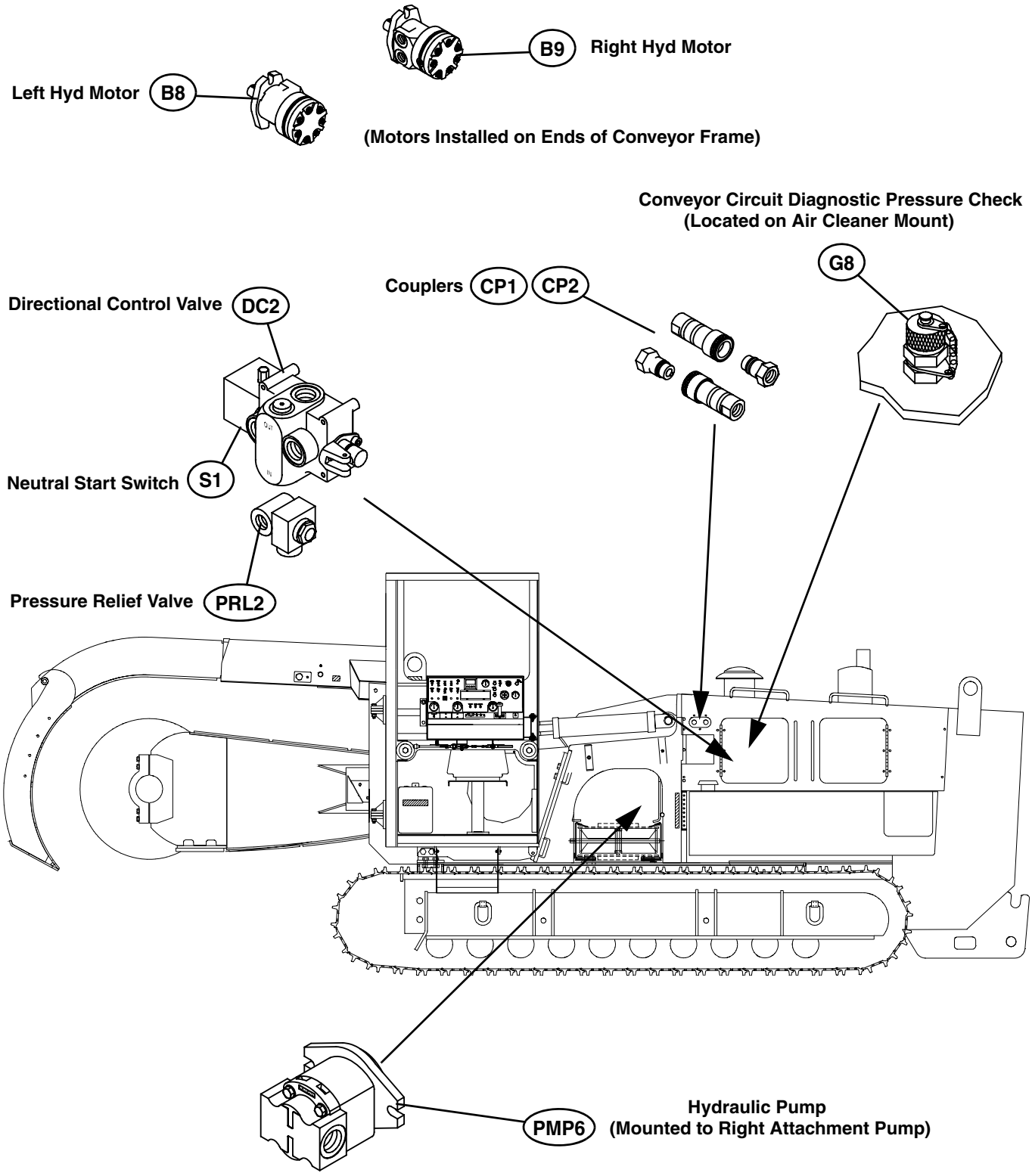
Circuits/Components

The following circuits and components are part of the Load/Return Conveyor subsystem.

Conveyor Rotation Circuit:

Fluid Conditioning Components
Hydraulic Pump PMP6
Hydraulic Motors B8 & B9
Directional Control Valve DC2 with Neutral Start Switch S1
Relief Valve PRL2
Quick Couplers CP1 & CP2
Conveyor Circuit Pressure Diagnostic Port G8

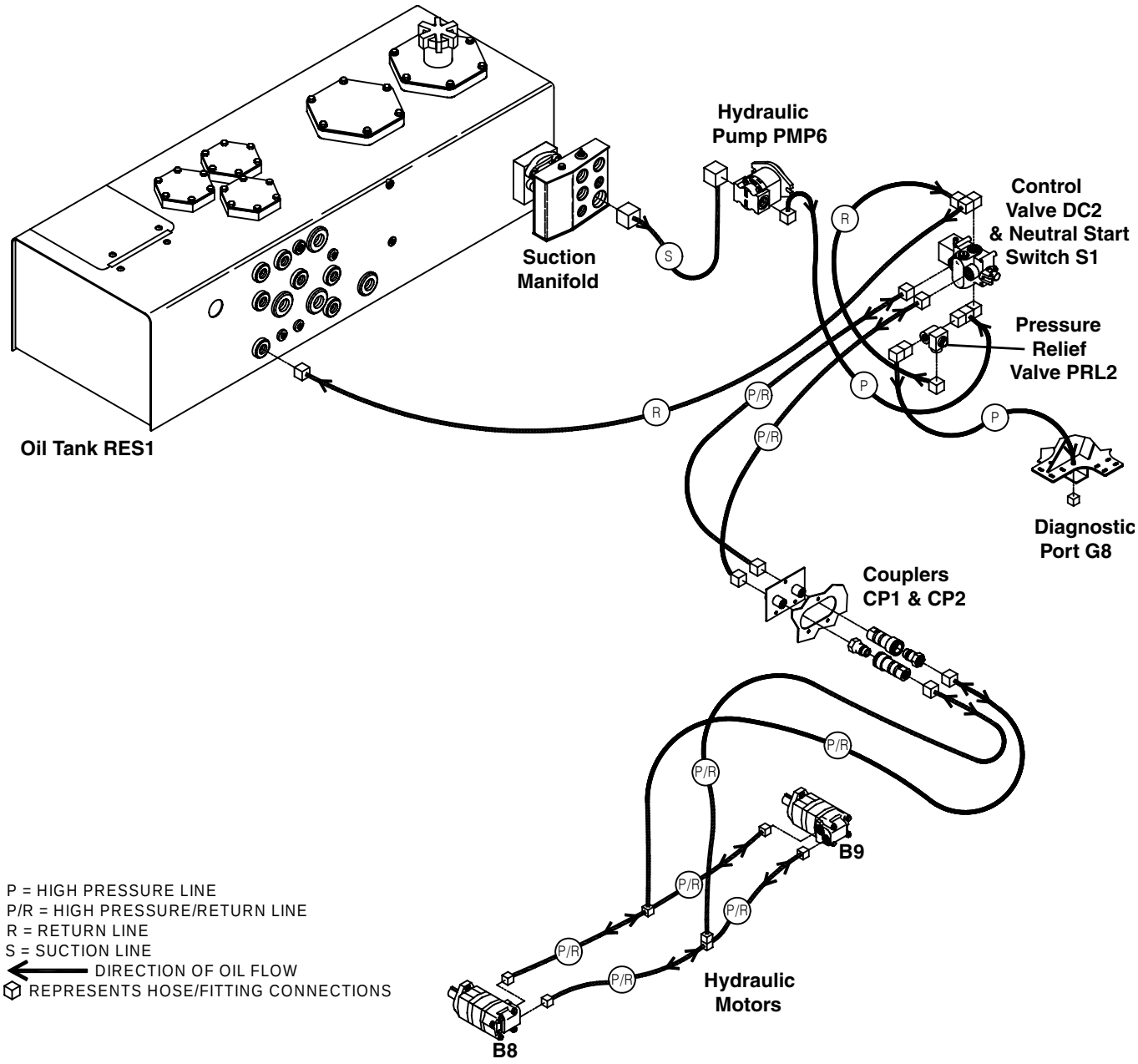
Component Locations



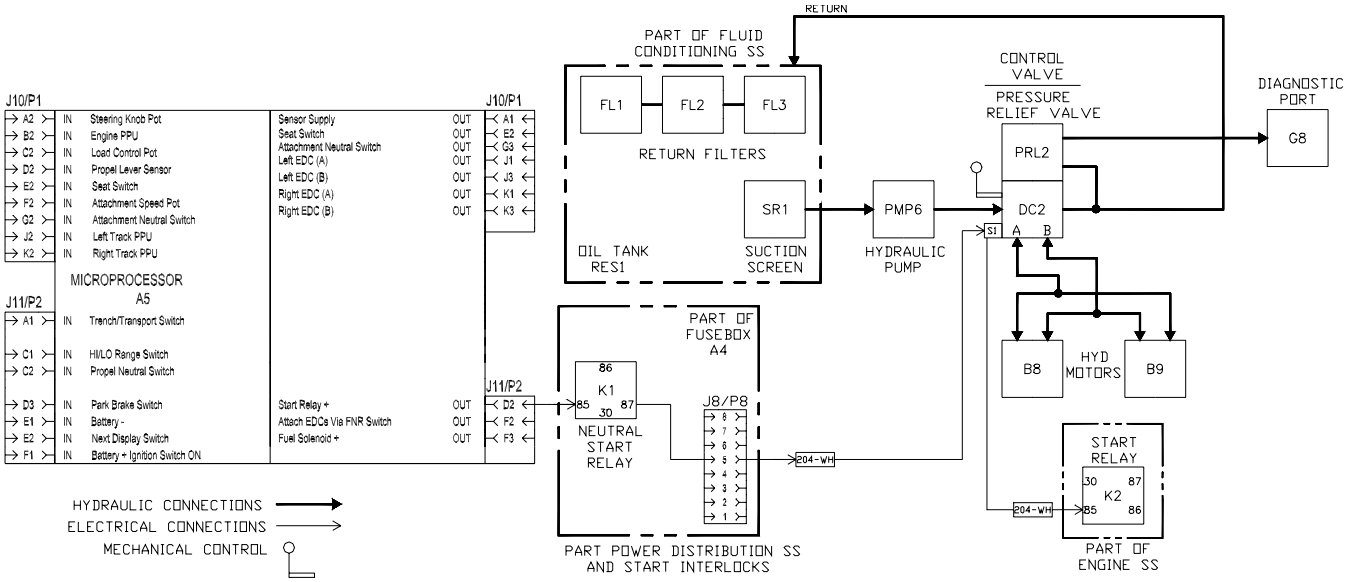
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Hydraulic Hose Connections

Note: Orientation of components does not reflect actual machine configuration.



CONVEYOR ROTATION CIRCUIT



Operation

The loading conveyor rotation circuit is controlled manually from a control lever installed in the operator station/cab. The lever controls both speed and direction of the conveyor. The control lever is located next to the cross conveyor control lever assembly. Trenching spoil is normally discharged alongside of machine during operation using the cross conveyor. The spoil can be discharged from either side of machine depending on the position of the cross conveyor control lever.

Using the crane feature, the loading conveyor can be positioned to receive the discharge from the cross conveyor. The spoil can then be loaded into a truck or directed away from the trench.

NOTE: The conveyor control valve DC2 has a neutral start switch S1 located in the control valve switch block assembly installed on the valve. The switch works off of a detent spool and is closed when conveyor lever is in NEUTRAL. This completes the circuit from the neutral start relay A4K1 to engine start relay K2. The switch is part of the machine's START interlock system. The conveyor control lever must be in the NEUTRAL position before engine will start. Refer to "Engine Start Interlocks," page **2-13** for detailed interlock operating information.

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Spoil Discharge

When pushing conveyor control lever from NEUTRAL, control valve DC2 spool will shift. Hydraulic oil flow from the uni-directional pump PMP6 is directed to the bi-directional rotation motors B8 & B9, turning them clockwise to discharge spoil. When pulling back the lever is, the spool shifts to opposite position to reverse conveyor.

The pressure relief valve PRL2 is set at 2000 psi (138 bar) to control maximum system pressure. Pressure spikes above 2000 psi (138 bar) will cause the relief valve to open. Oil flow will be directed back to the tank.

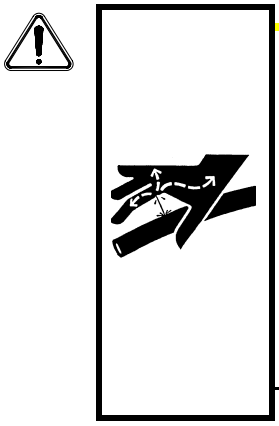
The diagnostic port G8 allows a pressure gauge to be installed for checking conveyor rotation circuit pressure.

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Chapter 11: Load/Return Conveyor Subsystem

Section B: Troubleshooting

OVERVIEW



WARNING: Pressurized fluid can penetrate body tissue and result in serious injury or death. Leaks can be invisible. Keep away from any suspected leak. Relieve pressure in the hydraulic system before searching for leaks, disconnecting hoses, or performing any other work on the system. If you must pressurize the system to find a suspected leak, use an object such as a piece of wood or cardboard rather than your hands. When loosening a fitting where some residual pressure may exist, slowly loosen the fitting until oil begins to leak. Wait for leaking to stop before disconnecting the fitting. Fluid injected under the skin must be removed immediately by a surgeon familiar with this type of injury.

Pretest Inspection

Before beginning any troubleshooting, review information in the General Information Chapter under “Troubleshooting Guidelines,” page 1-9.

If a malfunction occurs, do the following visual checks to inspect for obvious signs of failures before any testing is performed.

- Check for any obvious mechanical failures such as, broken linkages, cables, sprockets, chains, sheaves, pulleys, belts, and so on.
- Check hydraulic oil level in tank, especially if other subsystem/circuits are experiencing similar performance problems.
- Check hydraulic circuits for any obvious failures such as, broken, kinked, loose, or leaking motor or pump shaft seals, leaking hoses and fittings on supply, pressure, and return to hydraulic components. Also, check for broken, missing, corroded, or loose connections and wires that supply ground and power to electrical components.

Fault Chart

If no problems were found during the pretest inspection, refer to the fault chart on page 11B-3 and continue troubleshooting. The possible malfunctions listed do not cover everything that could go wrong with the circuits. They are meant to give a technician a logical place to begin, based on performance observations.

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Test Equipment Needed

IMPORTANT: The pressure and flow ratings of the test equipment used to conduct the following hydraulic test procedures must be equal to, or greater than the pressure and flow ratings of the circuit being tested.

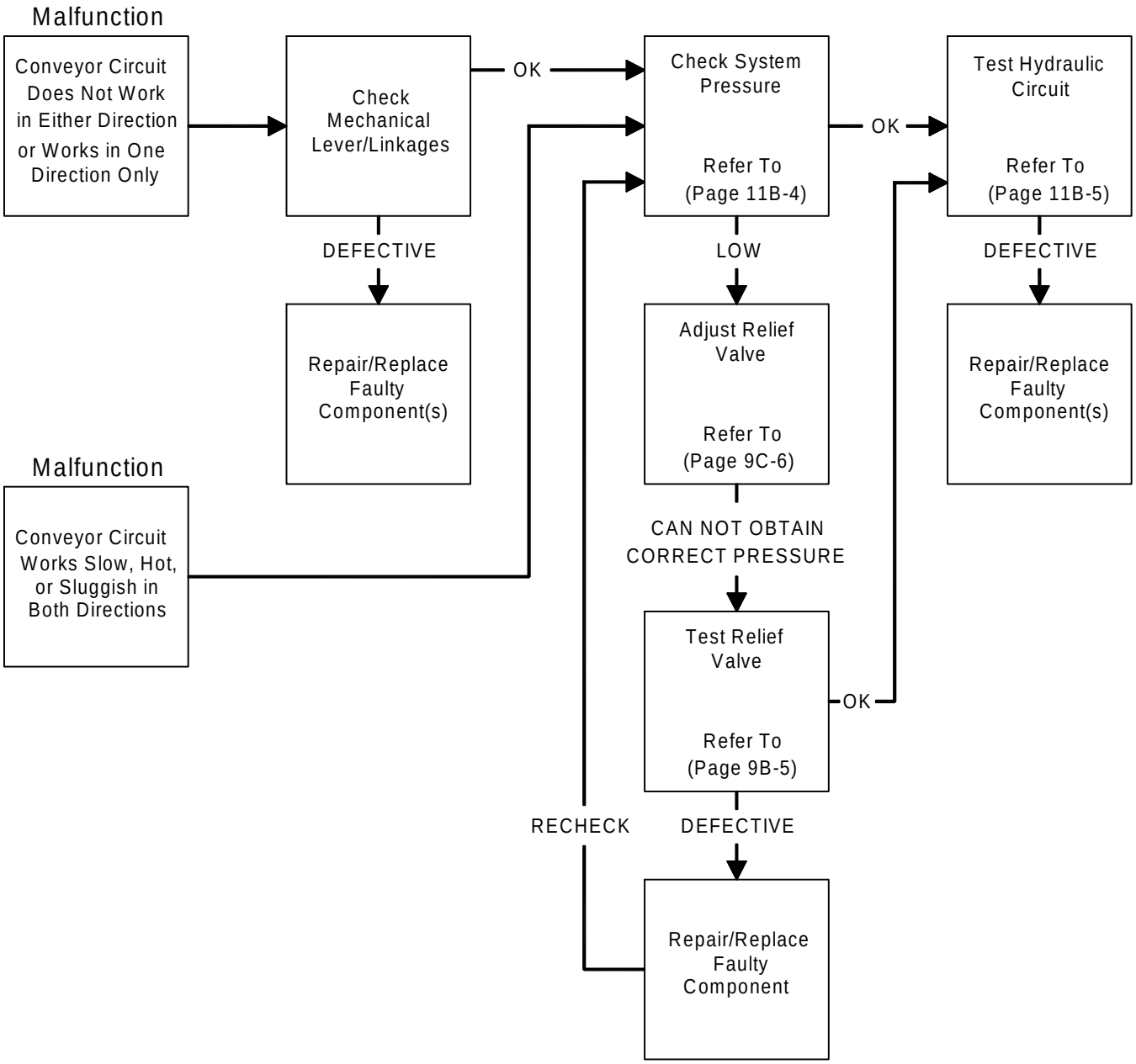
- Pressure Gauges
- Needle Valve
- Flow Meters
- Vacuum Gauge
- Phototachometer
- Pyrometer
- Digital Multimeter

Component Repair/Replace

If troubleshooting procedures determine a component is in need of repair or replacement, refer to section C for the appropriate repair procedures for those components.

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FAULT CHART



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CONVEYOR ROTATION CIRCUIT

Hydraulic Troubleshooting

The pressure in the hydraulic system should be checked to quickly determine how to begin to accurately troubleshoot the system. A diagnostic fitting located on the air cleaner mount is provided to check load/return conveyor drive pressure.

Snubbers are recommended to protect the pressure gauge. Gauge calibration is necessary to ensure accurate readings. If system pressure is correct, refer to page 11B-5 and test the hydraulic circuit for excessive leakage.

System Pressure - Check

To check the conveyor system pressure:

1. Install pressure gauge capable of at least 3000 psi (207 bar) in the conveyor pump system pressure diagnostic gauge port located on the air cleaner mount.
2. Remove hoses from conveyor drive motor(s). Cap fittings and plug hoses.
3. Start engine and set engine speed to full throttle.
4. Ensure hydraulic oil is warmed to at least 100°F (38°C).
5. Move conveyor lever either direction out of NEUTRAL and observe gauge.

   Expected result: The pressure gauge should read approximately 2500 psi (172 bar). If pressure is not within specification, try adjusting the valve. Refer to page 9C-6 of the Cross Conveyor Repair section. The procedure is the same.

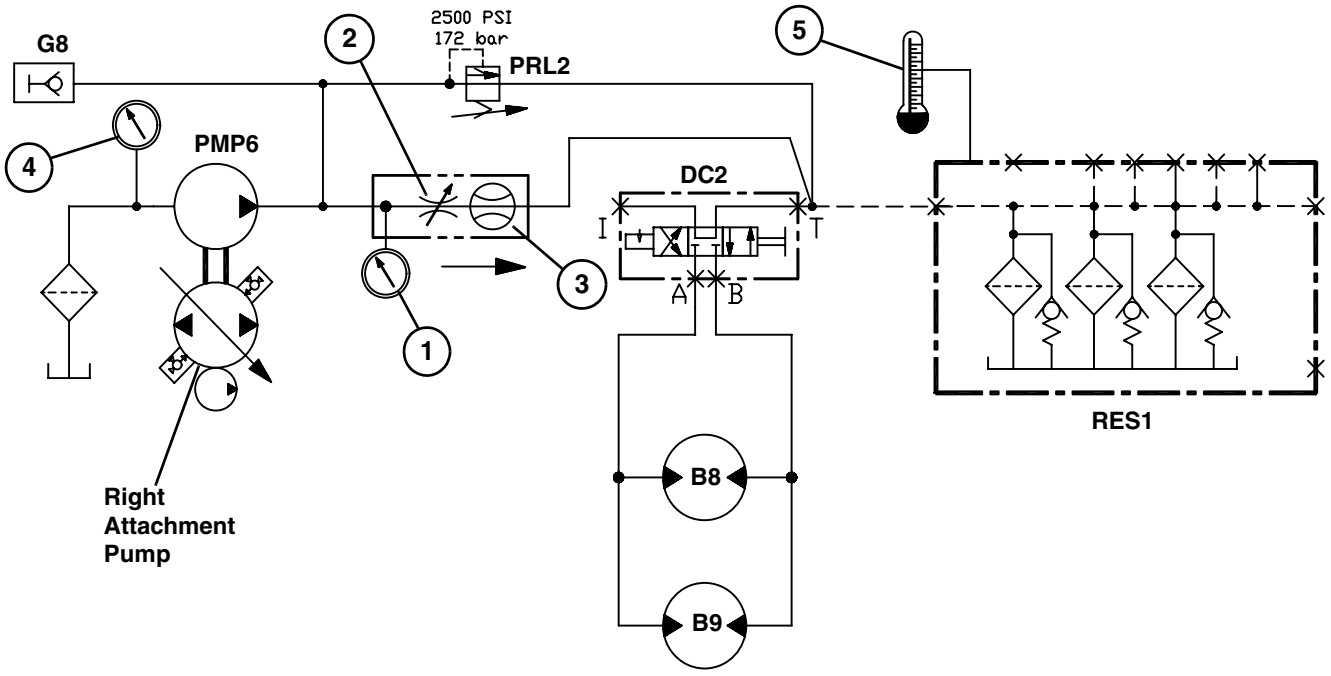
6. After adjustment, check relief valve pressure for proper setting as described above. If correct pressure can not be obtained, test relief valve. Refer to page 9B-5 of Cross Conveyor Troubleshooting section. The procedure is the same.
7. If test reveals the relief valve is OK, refer to the following page and test the rest of the hydraulic circuit.

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Hydraulic Circuit Test Procedures

The hydraulic circuit test procedure takes a logical approach based on component location and the degree of difficulty of testing components in the circuit. The following procedures begin with testing the pump. The test procedure will determine the amount of leakage across the ports of the pump. The control valve and motor(s) will be isolated from the hydraulic circuit during this test.

Pump PMP6 - Test



IMPORTANT: Ensure any hoses or fittings that are added to the test equipment are the same size and rating as hoses and fittings installed in the hydraulic circuit. Mismatched hose or fitting sizes can result in erroneous pressure indications. Mismatched pressure ratings can result in leakage or personal injury.

1. Shut down engine.
2. Turn ground disconnect switch to the DISABLE position.
3. Loosen fill cap on the tank to release any residual pressure in the system.
4. Remove hose from inlet of control valve and connect it to the inlet of flow meter **(3)**, needle valve **(2)**, pressure gauge **(1)** combination tool as shown. If a combination unit is not available, install a single flow meter, needle valve, or pressure gauge.

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5. Connect a length of hose from the outlet port of the flow meter to the connector at the oil filter or route it directly to the oil tank. Fasten it securely.

6. Open needle valve **(2)** fully (turn counterclockwise). The pressure gauge **(1)** will be parallel with the connector at the inlet port of flow meter.

7. Install a vacuum gauge **(4)** in parallel with the connector at the inlet port of pump.

8. Turn ground disconnect switch to enable position. Start engine and inspect test equipment connectors for leaks.

NOTE: If catastrophic failure is suspected, do not run engine for longer than is absolutely necessary to determine its condition. If metal fragments are found in the hydraulic lines, outlet port of pump, return filter, and/or tank, **do not** restart pump. Replace pump.

9. Allow system to warm up to approximately 130°F (54°C). If needed, cycle a machine function to aid in warming the oil. Observe pyrometer **(5)**.

10. Set engine speed to full throttle (2350 rpm). Verify engine speed on the TEC 2000 Display.

NOTE: The conveyor pump shaft is intregal to the right attachment pump. Therefore the pump speed must be verified. The engine must be able to maintain full throttle to achieve desired pump flow.

11. Record on worksheet:

- The pump (no-load) input shaft speed, in this case, the engine RPM. Ensure TEC 2000 display indicates 2350 rpm.
- The pump inlet restriction indicated on the vacuum gauge **(4)**.

NOTE: If the inlet restriction is within specification 5″ Hg (127 mm) continuous max., continue with test procedure. If pump inlet restriction is inconsistent with design specification, refer to page 4B-1 and ensure Fluid Conditioning subsystem components are operational. Continue with test procedure when pump inlet restriction is within design specification.

12. Operate pump at no-load. Record on test worksheet:

- Flow indicated on flow meter **(3)**.
- Pressure indicated on pressure gauge **(1)**.
- Fluid temperature indicated on pyrometer **(5)**.

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13. Gradually load pump by restricting the flow with needle valve **(2)** (turn clockwise). Stop when pressure reaches 100 psi (6.9 bar), more than no-load pressure.
14. Continue increasing the pressure increments of 100 psi (6.9 bar), plotting the flow and pressure at each 100 psi (6.9 bar) increment on test worksheet. Stop test procedure when 2500 psi (172 bar) is reached.
15. With engine operating at full load (full pump flow passing over relief valve), record on test worksheet:

- Engine speed indicated on TEC 2000 display.
- Fluid temperature indicated on pyrometer **(5)**.

16. Open needle valve **(2)** fully (turn counterclockwise) and reduce artificial load on pump.
17. Shut down engine and analyze test results.
18. At conclusion of test procedure, remove test equipment, reconnect hydraulic lines, motor and fan, and tighten the connections.
19. Start engine and check connections for leaks.

Analyzing Test Results

Diagnostic Observation 1:

- Flow meter **(3)** indicates a nominal flow decrease as the pressure drop across the pump ports increases. The flow decrease does not exceed the maximum leakage rating of pump, 8 gpm (30 L/min) with a nominal decrease in engine speed.
- The operating temperature of the fluid indicated on pyrometer **(5)** remains within design specification.
- The engine speed indicated on TEC 2000 display remains within design specification.
- Pump inlet restriction indicated on vacuum gauge **(4)** remains within design specification.

Diagnosis - The pump appears to be in satisfactory operating condition. Refer to page **11B-8** and test directional control valve assembly.

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Diagnostic Observation 2:

- Pyrometer **(5)** indicates a moderate increase in the operating temperature of the fluid.
- Engine speed indicated on TEC 2000 display remains within design specification.
- Pump inlet restriction indicated on vacuum gauge **(4)** remains within design specification 5″ Hg (127 mm) continuous max.

Diagnosis - The condition of the pump may be marginal. If there is an abnormal variation (reduction) in actuator speed which causes an unacceptable loss and/or a marked increase in the operating temperature of the fluid, the pump should be replaced.

Diagnostic Observation 3:

- Flow meter **(3)** indicates a progressive flow loss as the pressure drop across the pump ports increases. The flow loss exceeds 30% of the theoretical or (no-load) flow - 8 gpm (30 L/min) max.
- Pyrometer **(5)** indicates a progressive increase in operating temperature of the fluid which does not appear to level off.
- Engine speed indicated on TEC 2000 display remains within design specification.
- Pump inlet restriction on vacuum gauge **(4)** remains within design specification 5″ Hg (127 mm) continuous max.

Diagnosis - There appears to be excessive leakage across ports of pump. Replace pump.

Directional Control Valve DC2 - Test

The conveyor directional control valve has a built-in pressure relief valve. This valve is not used to set system pressure, the pressure relief valve installed on the inlet of the control valve is used to control system pressure at 2500 psi (172 bar). Refer to page 11B-4 for information on checking the relief valve pressure.

NOTE: Contaminants in hydraulic oil, over a period of time, can build up between the moving parts and housings and cause valve spools, check balls, and other components to stick. Leaking O-ring seals and backup washers can also affect the output flow of valves.

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Inspecting for excessive wear would involve removing the valve spool and checking the valve seats, O-ring seals, backup washers, spools, and other internal components. Replace any seals that are visually worn. If any other valve components are worn, the valve assembly will need to be replaced. Refer to page 9C-3 of the Cross Conveyor Repair section for information replacing or repairing the control valve. The procedure is the same.

Analyzing Test Results

Diagnostic Observation 1:

The visual inspections fail to find any worn or damaged valve seals or internal components.

Diagnosis - The condition of the valve appears to be OK. The motor(s) is most likely to be the component causing the malfunction in the circuit. Testing the motor for excessive leakage can be quite labor intensive. Compared to the price of a new motor it may not be cost effective. Therefore, it is up to the discretion of the technician whether or not to perform the motor test. If not testing, replace motor at this point. If testing the motor(s) is desired, see Motors B8 & B9 - Test.

Diagnostic Observation 2:

The visual inspections find worn or damaged valve seals, valve seats, spool, or other internal components.

Diagnosis - The condition of the valve appears to be faulty and is most likely to be the component causing the malfunction in the circuit. Repair or replace the control valve assembly. Refer to page 9C-3 of the Cross Conveyor Repair section for information replacing or repairing the control valve. The procedure is the same.

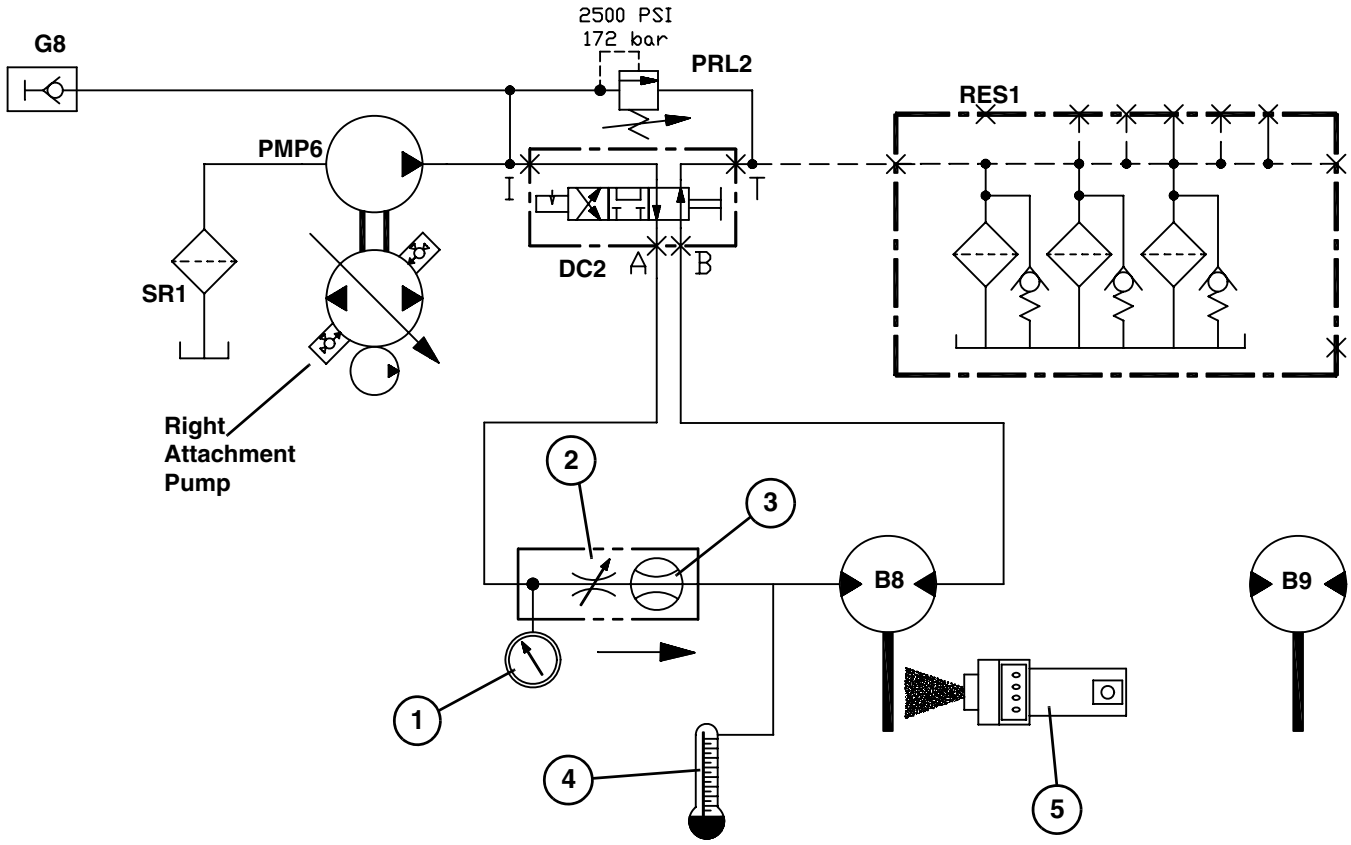
Motors B8 & B9 - Test

The illustration on the following page depicts the left motor being tested in the clockwise rotation. Damage to the test equipment can occur if it is not installed correctly. Note direction of the arrow on the flow meter when installing. The procedure will test the motors individually. The right motor will be removed from the circuit and tested after the left motor.

NOTE: The motor(s) should be tested in both directions. When testing opposite direction, install test equipment to the opposite port of motor.

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IMPORTANT: Ensure any hoses or fittings that are added to the test equipment are the same size and rating as hoses and fittings installed in the hydraulic circuit. Mismatched hose or fitting sizes can result in erroneous pressure indications. Mismatched pressure ratings can result in leakage or personal injury.

1. Shut down engine.
2. Make a photocopy of the motor test worksheet on page 11B-15.
3. Turn ground disconnect switch to the DISABLE position.
4. Loosen fill cap on the tank to release any residual pressure in the system.
5. Remove hydraulic hoses coming from right motor B9 at the tee connectors to allow the motors to be tested individually. Plug hoses and cap tee connector.
6. Install combination flow meter **(3)**, needle valve **(2)**, pressure gauge **(1)** as shown in series with the inlet port of left motor B8. If a combination unit is not available, install a single flow meter, needle valve, or pressure gauge.

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7. Open needle valve fully (turn counterclockwise).

8. To conduct the test, the motor needs to be disconnected from the conveyor assembly. The needle valve is used to generate an artificial load. Ensure motor is secured or clamped to the conveyor frame while testing to keep it from moving.

NOTE: If catastrophic failure is suspected, do not run engine for longer than is absolutely necessary to determine its condition. If metal fragments are found in hydraulic lines, inlet or outlet ports of motor, or return filters, **do not** operate the motor. Replace motor.

9. Turn ground disconnect switch to the ENABLE position. Start engine and inspect test equipment connections for leaks.

10. Allow system to warm up to approximately 130°F (54°C). If needed, cycle a machine function to aid in warming the oil. Observe pyrometer **(4)**.

NOTE: For accurate test results, check and adjust if necessary, the pressure relief valve. Refer to page 11B-4.

NOTE: Pump flow is proportional to motor input shaft speed. If there is a reduction in pump flow because of engine speed, it will directly affect motor shaft speed. It is necessary to determine pump shaft speed prior to testing. The engine RPM must be correct and used to determine pump shaft speed.

11. Start engine and set engine speed to full throttle (1200 rpm). Verify engine speed on TEC 2000 LCD display.

12. Actuate control valve (full flow) and record on test worksheet:

- No-load pressure indicated on pressure gauge **(1)**.
- No-load motor shaft speed indicated on tachometer **(5)**.
- No-load flow into motor indicated on flow meter **(3)**.
- Fluid temperature indicated on pyrometer **(4)**.

13. Gradually load system by restricting the flow into the motor with needle valve **(2)** (turn clockwise). Load system in 100 psi (6.9 bar) increments.

14. At each 100 psi (6.9 bar) increment, record on the graph of test worksheet:

- Pressure indicated on pressure gauge **(1)**.
- Motor shaft speed indicated on tachometer **(5)**.
- Flow into motor indicated on flow meter **(3)**.

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15. Stop test procedure when the value of the relief valve is reached at 2500 psi (172 bar).
16. Record on test worksheet, the full-load engine RPM indicated on TEC 2000 LCD display.
17. Open needle valve fully (turn counterclockwise).
18. Shut down engine and analyze test results.
19. At conclusion of test procedure, remove test equipment. Reconnect hydraulic lines and tighten the connections.
20. Install motor back onto the conveyor frame, start engine and check connections for leaks.
21. Test right motor using the same instructions as the left.

Analyzing Test Results

Diagnostic Observation 1:

- Flow meter **(3)** indicates a moderate to high flow decrease as needle valve **(2)** creates an artificial load on the hydraulic system.
- Tachometer **(5)** indicates a reduction in motor shaft speed which is proportional to the flow decrease.
- Pyrometer **(4)** indicates a moderate increase in the operating temperature of the fluid.
- Engine speed remains within design specification.

Diagnosis - The loss in motor shaft speed is proportional to the decrease of flow into motors. This indicates that the motors are OK. The pump has also been tested at this point and proven to be within design specification. The directional control valve has been inspected and visually appeared to be OK, but is most likely leaking excessively internally. Replace valve. Refer to page 9C-3 of the Cross Conveyor repair section for information. The procedure is the same.

Diagnostic Observation 2:

- Flow meter **(3)** indicates a marginal flow decrease as needle valve **(2)** creates an artificial load on the hydraulic system. The flow decrease is not more than the anticipated loss relative to the maximum leakage specification of the pump, and nominal decrease in engine speed.
- Tachometer **(5)** indicates a progressive decrease in motor shaft speed as the load at the motor output shaft increases during a normal load cycle. The speed decrease approaches, or exceeds, the maximum design specification of motor no-load speed.

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- Pyrometer **(4)** indicates a progressive increase in the operating temperature of the fluid which does not appear to level-off.
- Engine speed remains within design specification.

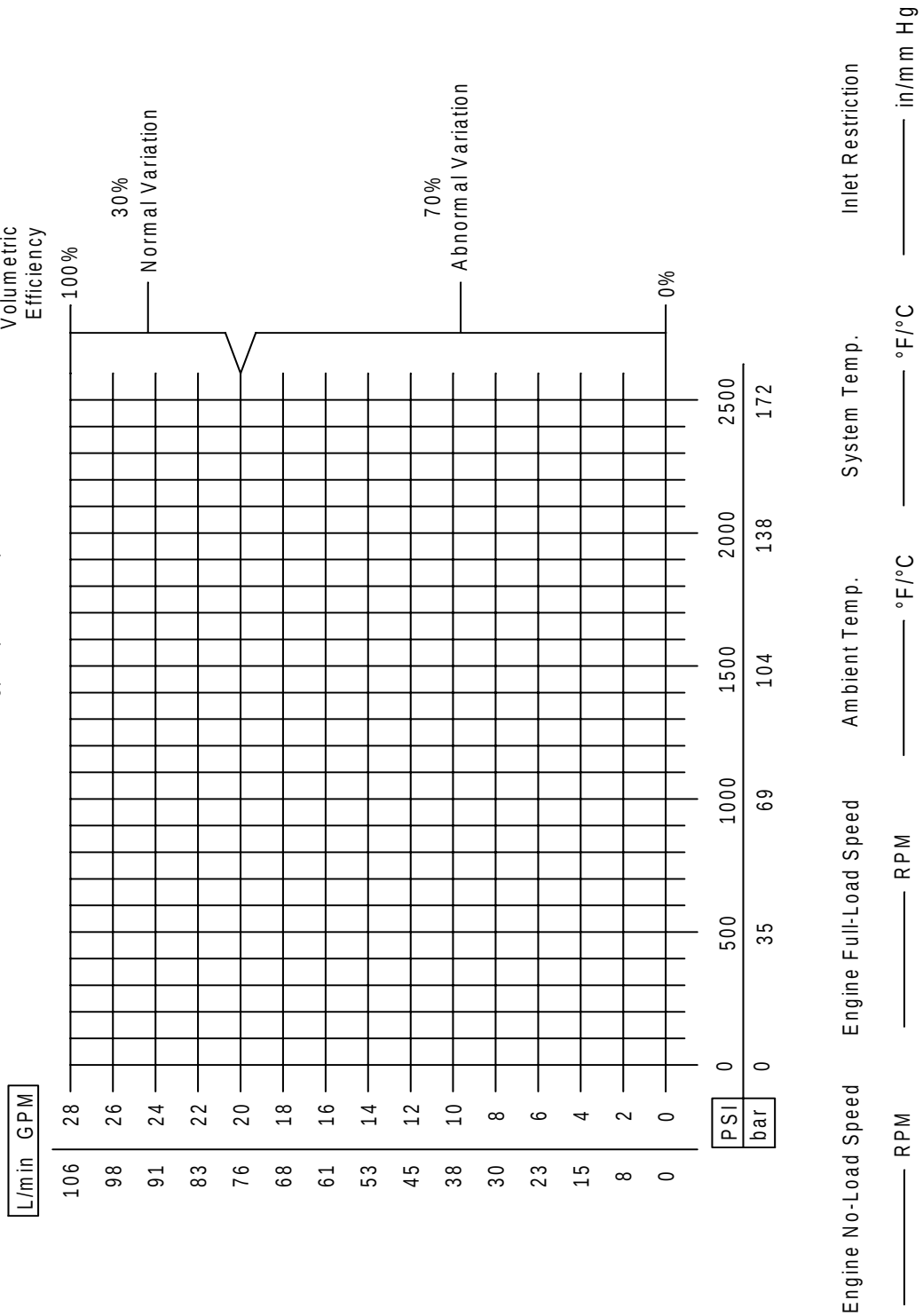
Diagnosis - If the flow meter indicates that the flow into motors remain within the design of the system, and the tachometer indicates a speed decrease which causes an unacceptable loss in motor shaft speed, leakage across the motor(s) is excessive. Replace motor(s).

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Pump Worksheet

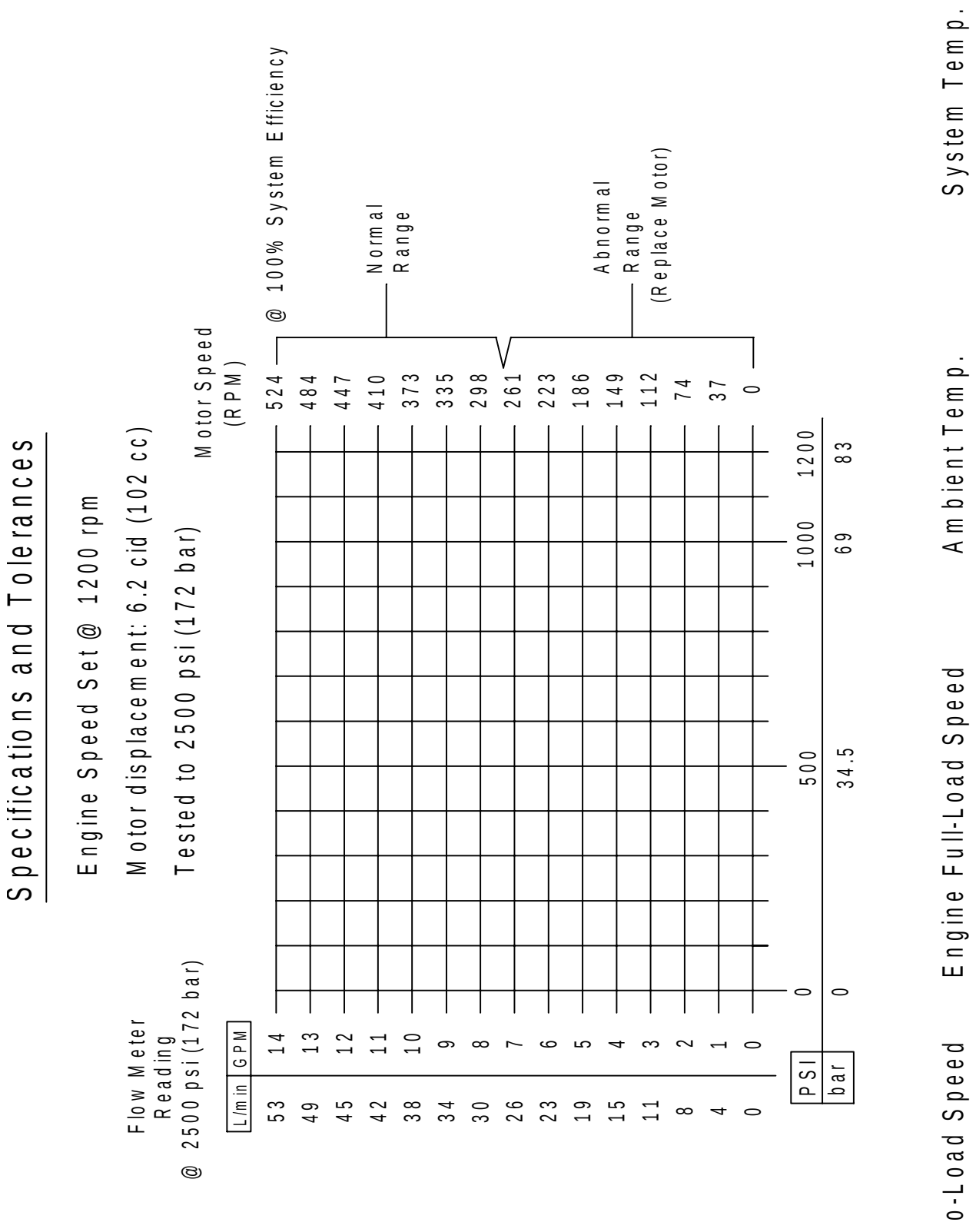
Specifications and Tolerances

Engine Speed Set @ 2350 rpm
Pump displacement: 2.32 cid (38 cc)
Tested to 2500 psi (172 bar)
Pump Inlet Restriction: 5" Hg (127 mm) Continuous Max.
Nominal Case Drain Flow 6 gpm (23 L/min)
Maximum Case Drain Flow 8 gpm (30 L/min)



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Motor Worksheet



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Chapter 11: Load/Return Conveyor Subsystem

Section C Repair

SUMMARY

For general service information and conveyor installation instructions, refer to the LRC25 Conveyor Operator's Manual with Parts Lists (P/N 105400H57).

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Chapter 12—Cab Subsystem

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Chapter 12: Cab Subsystem

Section A: Theory

OVERVIEW

The Cab subsystem consists of the circuits and components necessary to operate the optional cab features.

Circuits/Components

Air Conditioning/Heater Circuits:

Compressor
Condenser
Receiver/Dryer
Pressure Switch S33

Control Circuits:

Part of Air Conditioning/Heater Unit A11 including:
- Cab Fuses
- Fan Speed Switch S1
- Air Conditioning/Heater Control Switch S2

Windshield Wiper & Accessory Circuits:

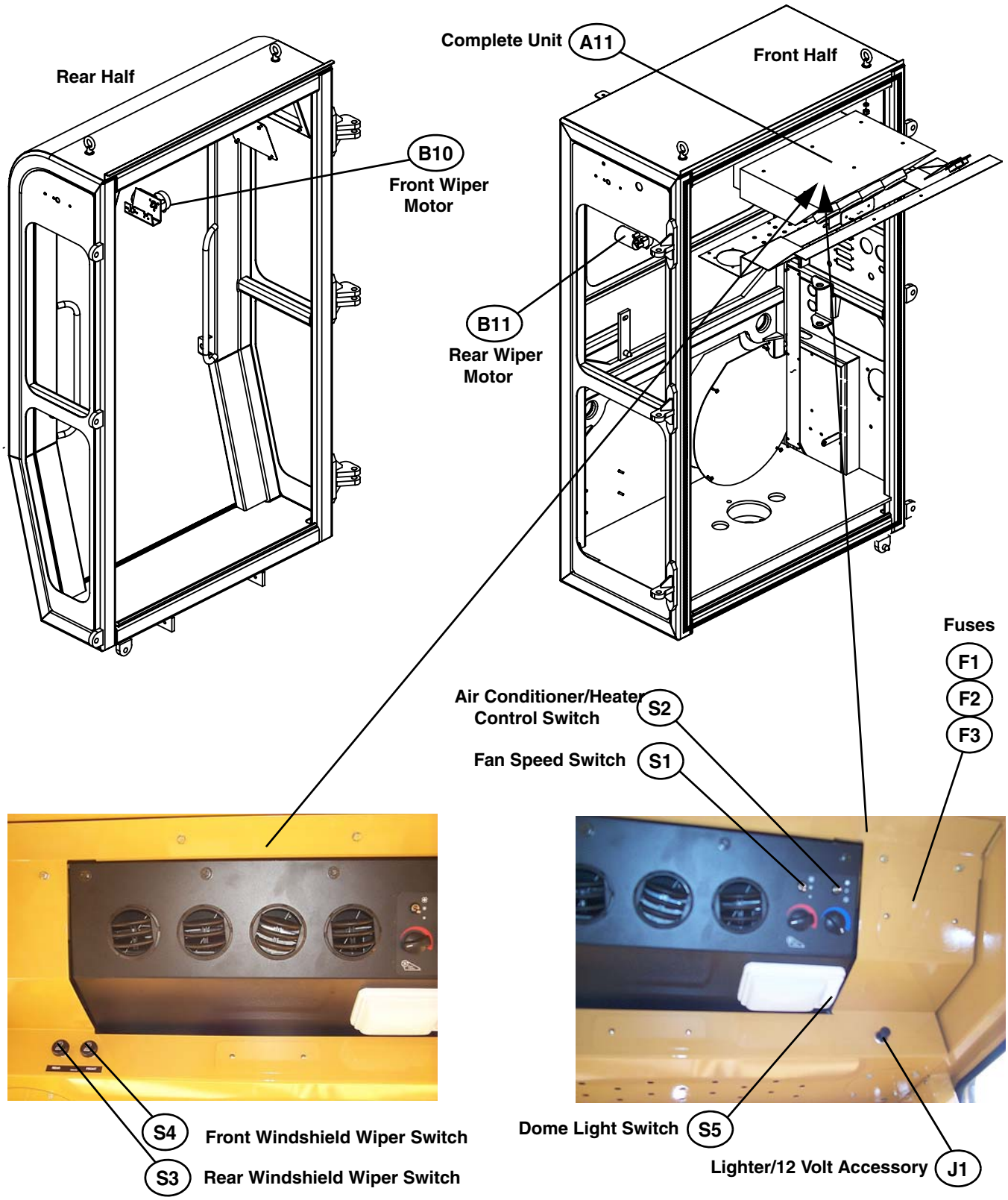
Part of Air Conditioning/Heater Unit A11 including:
- Cab Fuses
- Rear Windshield Wiper Switch S3
- Front Windshield Wiper Switch S4
- Dome Light Switch S5
- Lighter/12-Volt Accessory Outlet J1

Front Wiper Motor B10
Rear Wiper Motor B11

Horn Circuit:

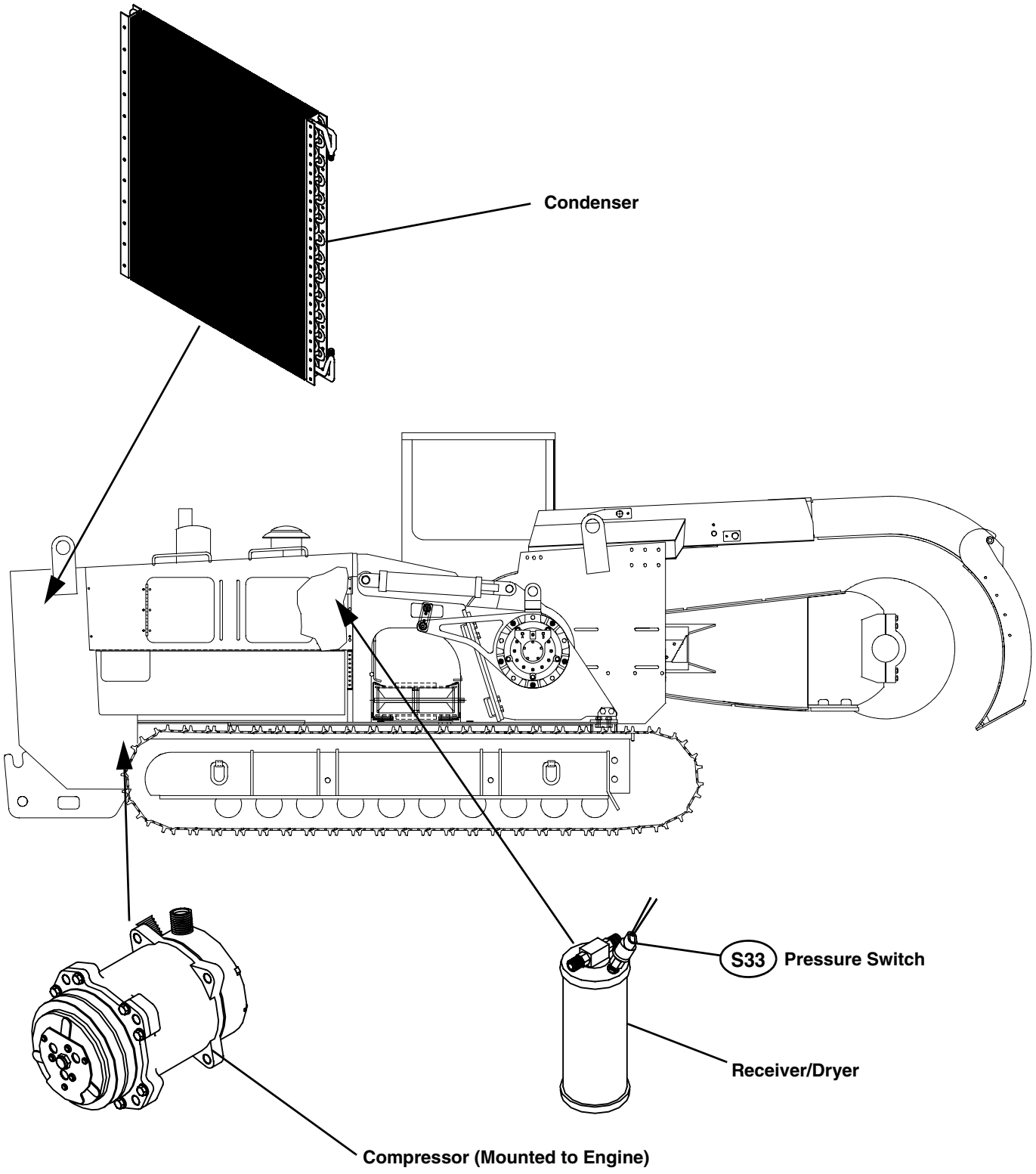
Fuse F8
Horn AD2
Horn Switch S34

Component Locations



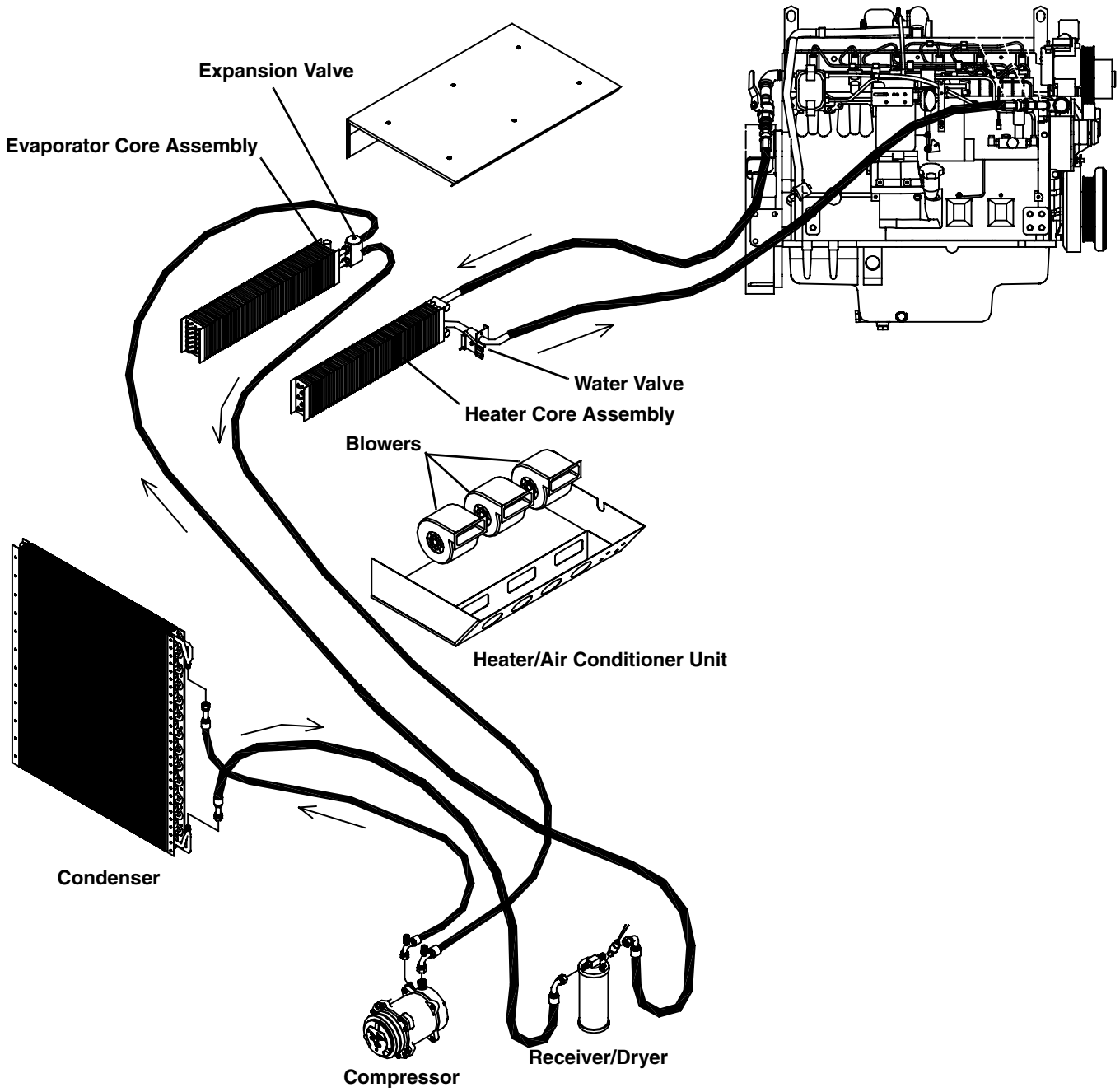
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Hose Connections

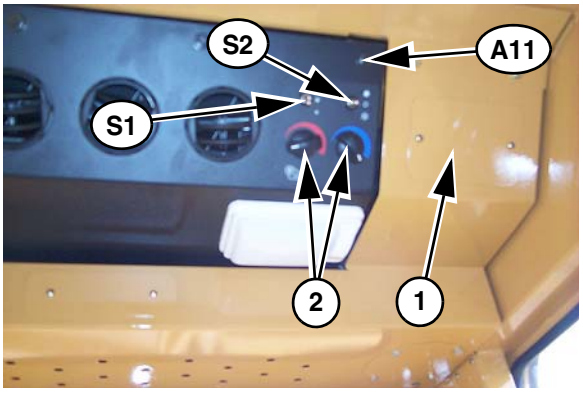


AIR CONDITIONING/HEATER CIRCUITS

Operation

Control Circuits

The air conditioning and heater circuits are controlled from components installed in assembly A11.



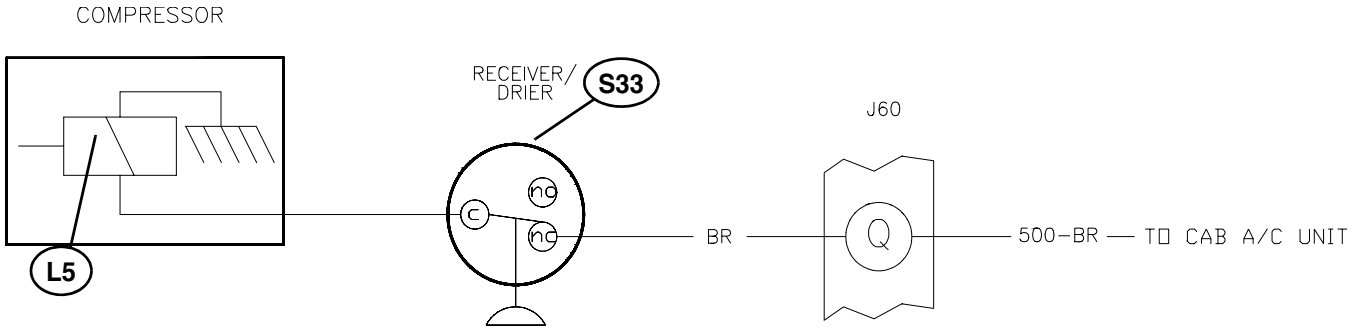
(1) - Fuses

(2) - Thermostat Control Knobs

S1 - Fan Speed Switch

S2 - Air Conditioner/Heater Switch

Air Conditioning Circuit



Compressor:

The compressor is powered by a drive belt from the engine. The compressor's primary function is to compress and pressurize the gaseous refrigerant known as R134A. When the heater/air conditioning switch S2 on the control unit is switched to air conditioning, the circuit is complete through the pressure switch S33 located on the receiver/dryer to energize the compressor coil L5.

The compressor has an electrically operated engagement clutch to turn the refrigeration ON. When ON, cool gas enters the compressor suction or inlet port. The gas that exits at the discharge port is under high pressure and hot.

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Pressure Switch:

The normally-closed pressure switch **S33** senses the pressure in the high side of the system. The switch regulates the compressor. As the air in the cab gets cooled, the pressure on the low side of the system drops. When the pressure drops below the preset low setting, or rises above the preset high setting, the switch will open, cutting off power to the compressor.

Condenser:

The condenser cools the hot gas from the compressor and turns it to liquid through the use of cool air provided by the engine fan. The liquid is still under high pressure and is warm.

Receiver/Dryer:

The liquid exits the condenser and enters the receiver/dryer. There is no pressure or temperature change at the receiver/dryer. The output is the same as condenser but moisture is removed by a dessicant bag located inside the receiver/dryer.

Evaporator Assembly:

As the high pressure, warm liquid, exits the dryer, it passes through an expansion valve located on the evaporator assembly. The pressure drop across the valve modulates refrigerant flow. The high pressure entering the valve is reduced considerably and the result is cold liquid exiting in the expansion valve under low pressure. The low pressure cold liquid is fed into a evaporator coil. Warm air in the cab is blown across the evaporator and cooled by the cold liquid in the evaporators coil.

As the air is cooled, the liquid refrigerant is heated in the other side of evaporator and then evaporates. The evaporated gas then returns to the compressor suction port to begin the process again.

Heater Circuit

Hot coolant from the engine is supplied to the inlet of the heater core from the engine head. The hot coolant flows through the coils of the heater core and back to the engine's water pump for re-circulation. The blower fans blow air through the fins of the core to provide the warm air in the cab.

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WINDSHIELD WIPERS AND ACCESSORY CIRCUITS

Operation

Control Circuits

The circuits are controlled from components installed in assembly A11.

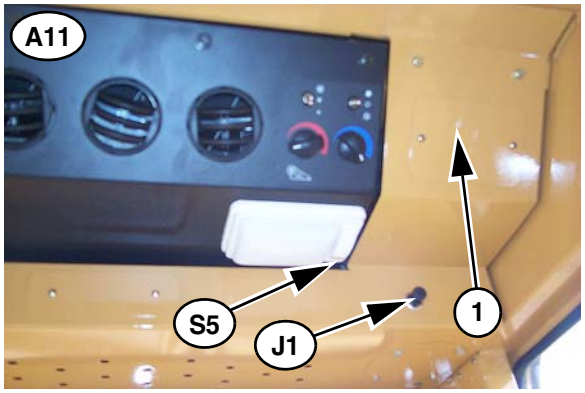
S3 - Rear Windshield Wiper Switch

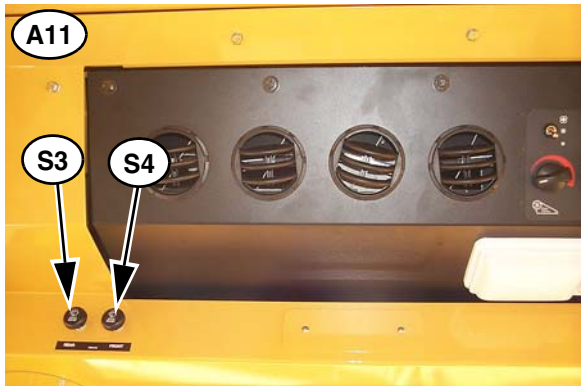
S4 - Front Windshield Wiper Switch

S5 - Dome Light Switch

J1 - Lighter/12-Volt Accessory

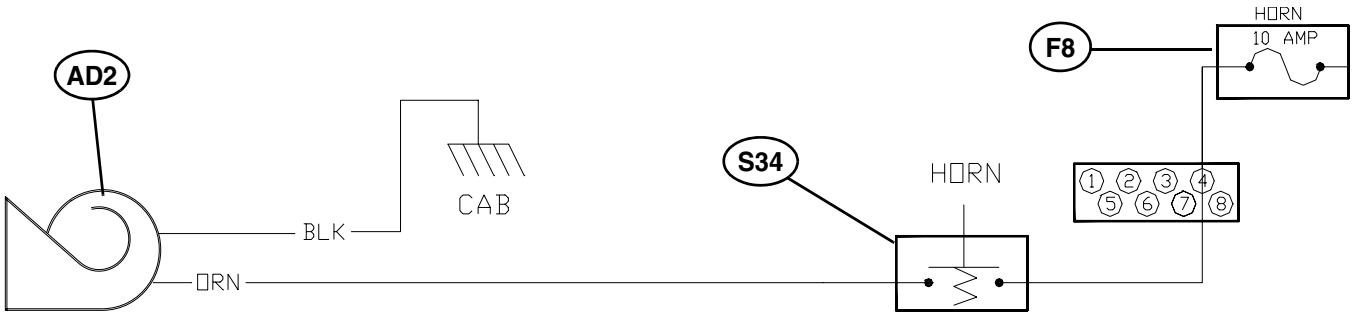
The circuits get power from the fuses in the fuse box **(1)**. When switches are moved from their OFF positions, a voltage path is complete allowing current to the wiper motors and dome light.



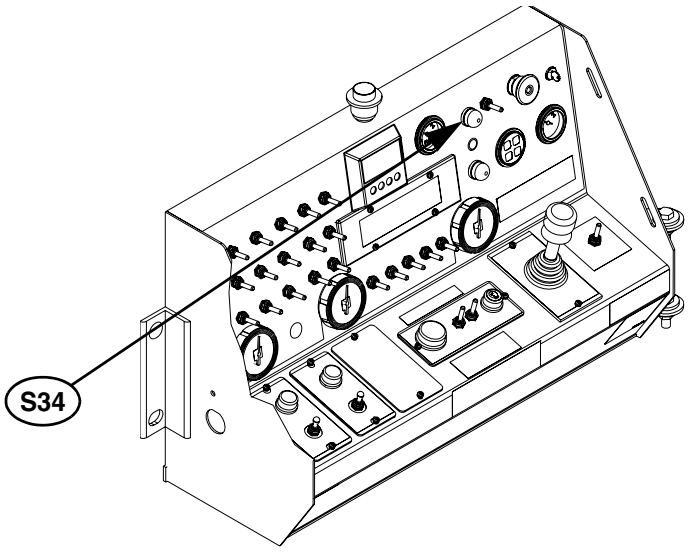


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HORN CIRCUIT



Operation



The horn switch S34 located on the control console assembly, gets power from a 10-amp fuse F8 located in the main fuse box. To sound the horn AD2, the operator pushes the switch. This completes the voltage path allowing current to energize the horn.

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Chapter 12: Cab Subsystem

Section B: Troubleshooting

OVERVIEW

Pretest Inspection

Before beginning any troubleshooting, review information in the General Information Chapter under “Troubleshooting Guidelines,” page 1-9.

If a malfunction occurs, do the following visual checks to inspect for obvious signs of failures before any testing is performed.

- Check for any obvious mechanical failures such as, broken or loose compressor belt, linkages, cables, mounting brackets and so on. If no mechanical problems are found, continue inspecting for any obvious failures such as, broken, or loose hoses and fittings on supply, pressure, and return to components.
- Check the refrigerant in the sight glass of the receiver/dryer. There should be no bubbles visible. A continuous stream of bubbles indicates the refrigerant is low and there is probably a leak. Check for any obvious refrigerant leaks. Refrigerant oil leaks out with the refrigerant and leaves an oily film that collects dust. Look for signs of oil and dirt around compressor clutch. The clutch will sling oil if there is a leak.
- Inspect for any coolant leaks. Inspect for any debris that may be blocking air flow through the condenser, evaporator, or heater core. Also, check for broken, missing, corroded, or loose connections on the ground and power wires that supply the electrical circuit components.

Correct any problems found.

Test Equipment Needed

WARNING: Observe the following precautions when working around the air conditioner.

NOTE: Never service the air conditioner unless you have the proper equipment and know how to use it correctly. The air conditioner system contains high pressure liquid and vapor. The liquid if released, can turn to vapor almost instantly, freezing anything it touches, including skin and eyes.

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NOTE: If not equipped with the following service equipment, take the machine to an authorized service center for diagnosis and repair.

- Reclaimer - for collecting the refrigerant for recycling.
- Flushing Agent - to remove refrigerant oil and debris after reclaiming.
- Manifold Gauge Set - for checking low and high circuit pressures.
- Vacuum Pump - to evacuate or remove air and moisture out of the system.
- Mobile Air Conditioning Service Center - does all the above in one unit.
- Multimeter - to test electrical circuits for opens, shorts, or high resistance.

Component Repair/Replace

If troubleshooting procedures determine a component is in need of repair or replacement, refer to section C for the appropriate repair procedures for those components.

AIR CONDITIONING/HEATER CIRCUITS

The possible malfunctions listed below do not cover everything that could go wrong with the circuits and are only meant to give a technician a logical place to begin, based on how the machine is performing.

Possible Malfunctions

- Certain cab control circuit(s) do not operate correctly. Refer to cab control circuit troubleshooting.
- Air conditioner does not work at all, or works but does not cool sufficiently. Refer to air conditioning circuit troubleshooting on page 12B-4.
- Heater does not work at all, or works but does not heat sufficiently. Refer to heater circuit troubleshooting on page 12B-6.

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Cab Control Circuits Troubleshooting

The cab control circuits include the air conditioning and heater control thermostat, fan speed, and air conditioner/heater control. They also include the windshield wipers and accessories. All these circuits are contained in the ventilation, air conditioning, and heater assembly.

NOTE: A schematic of the cab electrical control circuits was not available at time of printing. If any electrical malfunctions occurs in the cab control circuits, first test the cab fuses. If a fuse is blown, replace it with the same type and rating. If fuse continues to blow, test the appropriate circuit for a short using a multimeter. Refer to the following page for information. If fuses are good, test the circuit wiring and components of circuit not working for opens, or high resistance using a multimeter:

Open Circuit Test

1. Test for an open in the circuit by testing acceptable voltage on power input and output pins/terminals of plugs and components. Testing at these points, starting at the load and working through the circuit will isolate the failed component by process of elimination. Continue through the steps until the open is found.

   Expected result: When placing the positive lead before an open point, the meter will read full battery voltage. When placing the lead beyond the open, the meter will read no voltage, indicating that a complete circuit exists from the chassis ground to the point where voltage is last seen in the circuit.

2. Once the open is found, turn ignition switch OFF, unplug wire harness at the suspected component and test component for continuity. If the component is OK, test wires connecting the component for continuity. Replace faulty component or section of wire harness. If battery voltage is measured at all points, continue next by measuring for voltage on ground side.

3. Normal voltage should measure 0.0–0.5 volts. If battery voltage is measured on the ground side, a poor connection or broken wire/cable is indicated. Test wires connecting the component for continuity. Replace faulty section of wire harness.

High Resistance Test

Measurements taken from a multimeter can be used to troubleshoot for unwanted resistance. Use multimeter to test for lower than normal battery voltage (voltage drop) while moving to accessible points in the circuit wiring. Replace section of failed wire harness.

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Short Circuit Test

1. Test for a short in the circuit. When testing the circuit for a short, turn ignition switch OFF and set multimeter to measure resistance (ohms). Work through the circuit, if the meter measures resistance through the complete circuit, it may be an intermittent problem causing the short. In that case, repeat the procedure and move the wiring harness or tap on components while watching for a sudden drop in resistance (Ω).

   Expected result: If the voltage side of the circuit is shorted to ground, the meter will read 0.0 Ω This indicates there is no resistance between check points (a dead short). Work through the circuit until the short is located. When the short is removed, the meter will return to a resistance reading.

2. Repair or replace faulty component or section of wire harness. Check circuit for function.

Air Conditioner Circuit Troubleshooting

IMPORTANT: The law requires recycling of CFC (chlorofluorocarbons) or HCFC (hydrochlorofluorocarbons) and banning the release of refrigerants during service, maintenance, and disposal of air conditioning and refrigeration equipment. It is illegal to intentionally release refrigerants into the atmosphere. The law requires technicians who repair vehicle air conditioning to be trained and certified by an EPA-approved organization. Training programs must cover the use of recycling equipment.

The most common problem associated with an air conditioning circuit that does not work at all or is not cooling sufficiently, is most likely a refrigerant leak. When the circuit leaks refrigerant, the air conditioner will not work well on hot days but may work better at night when ambient air temperature cools.

NOTE: If initial pre-test inspection does not reveal an obvious leak, continue with the following troubleshooting procedure.

Do a dynamic check with the engine speed at approximately 2000 rpm.

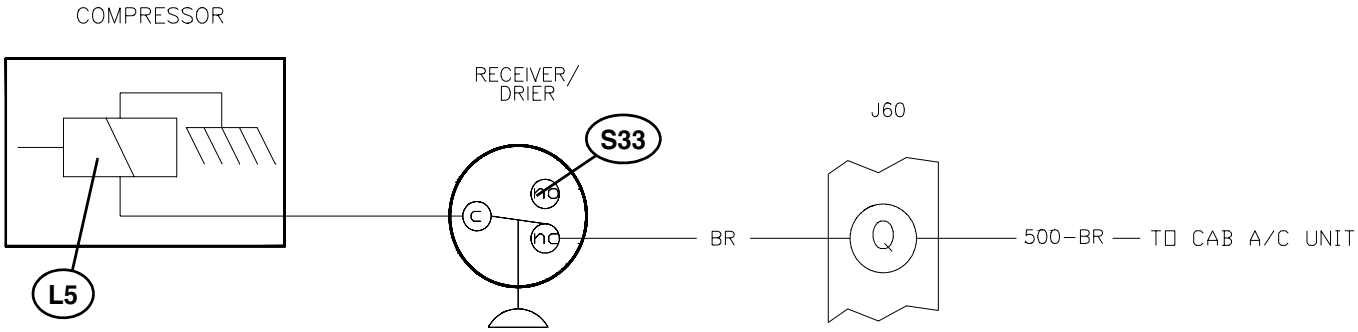
1. Turn on the air conditioner and run blower fan at low speed to put the circuit under low load to help draw in refrigerant.

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2. Check to see if the compressor is running by looking at the clutch hub mounted on the front of the compressor shaft.

   Expected result: The clutch should turn. If so, go to step 4. If not, either there is not enough refrigerant charge to supply the needed low side pressure or the electrical circuit is faulty. Continue with step 3 and test electrical circuit.



3. Check electrical circuit for power and ground from the cab control unit to the compressor by testing for opens, shorts or high resistance. See cab control circuits troubleshooting on page 12B-3 for testing details. If OK, is the compressor making abnormal noises? If yes, replace compressor. If not, continue with step 4.

4. The pressure in the air conditioner circuit can be checked to quickly and accurately verify the refrigerant charge. Refer to the instructions supplied by the equipment manufacturer for installing and measuring low and high side pressures.

Abnormal Cycle

Low Side Pressure

The low side pressure (suction side) on a working air conditioning circuit should measure approximately 40 psi (276 kPa) when outside temperature is hot. As the circuit loses refrigerant, the low side pressure will continue to drop. When the pressure drops to approximately 25–30 psi (172–207 kPa), the switch will open, cutting off power to the compressor.

High Side Pressure

When the compressor stops, the high pressure side of the circuit will bring pressure up as the circuit equalizes. The switch will sense when the pressure rises above 30 psi (207 kPa) and the compressor will turn ON again. This cycle will continue. The less refrigerant in the circuit, the more the pressure switch will turn the compressor OFF and ON. After a certain point, if the leak is not fixed, the compressor will not run at all.

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Normal Cycle

To regulate the compressor under a normal operating cycle, the correct amount of refrigerant charge must be present. The normal cycle uses high side pressure in the circuit to regulate the compressor ON/OFF. When high pressure reaches approximately 300–340 psi (21–23 bar), the pressure switch will turn off the compressor.

Expected result: The pressures should measure in the normal ranges as discussed above. If not, continue with step 5 and reclaim, flush, evacuate and recharge the circuit.

NOTE: There are a variety of air conditioning service equipment manufacturers. The air conditioning service equipment is capable of checking the pressures in the refrigerant circuit, reclaiming the existing refrigerant for recycling, flushing the circuit, leak detection, and circuit recharging. Therefore detailed instructions for performing the service steps are not given. Refer to the instructions supplied by the equipment manufacturer of the service unit being used.

5. Using the appropriate air conditioning service equipment, search for leaks. When leaks are found, repair faulty components.
6. Using the appropriate air conditioning service equipment, reclaim, recycle, and recharge the circuit. Check to ensure pressures are correct.

IMPORTANT: It is a good idea to have a new receiver/dryer installed each time the air conditioning circuit is opened.

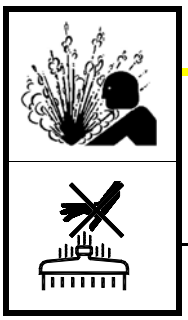
Heater Circuit Troubleshooting

The most common problem associated with a heater circuit that is not heating sufficiently, is most likely a low engine coolant level and/or low engine temperature.

NOTE: If initial pretest inspection does not reveal an obvious problem, continue with the following troubleshooting procedure.

Continued on next page...

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WARNING: Hot fluid under pressure can scald.

Allow engine to cool before opening radiator cap.

1. Check coolant level in the radiator. If low, fill radiator with a low-silicate (ethylene glycol) antifreeze and clean water mixture. If OK, continue with step 2.

NOTE: Never add pure antifreeze to a cooling system. Vermeer recommends using a 50/50 mixture. Never use high-silicate antifreeze or antifreeze that is higher than 60/40 mixture.

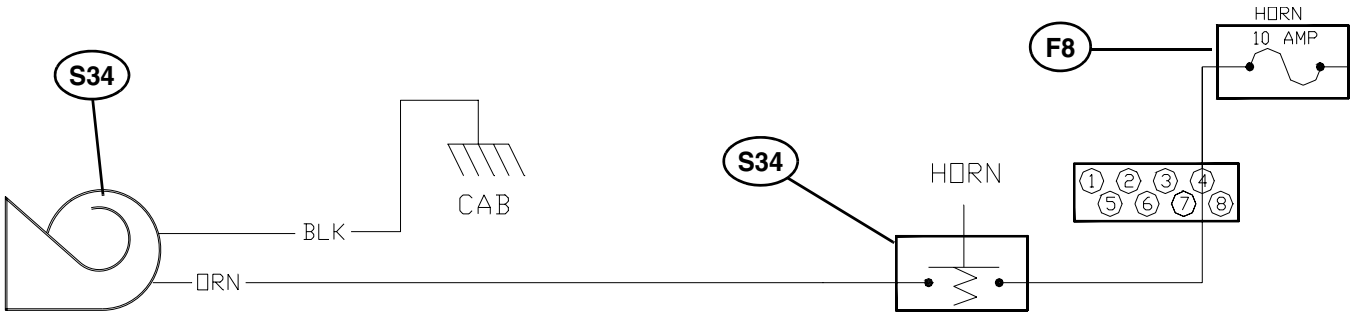
2. With the engine running, ensure the coolant temperature gauge on the control console is in the normal range. If temperature reaches 205°F (104°C), the engine will shut down. If engine shuts down, continue with step 3. If not, go to step 4,
3. Refer to the John Deere engine service manual and replace the engine coolant thermostat. If problem persists, continue.
4. Check heater core for restrictions. At full operating temperature, carefully feel the heater hoses. Use a rag or thin gloves if necessary to protect hands.

   Expected result: Both hoses should be similar in temperature. If one is considerably cooler than the other, the heater core is restricted.

5. Flush heater core. If restriction is still present, replace heater core.

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HORN CIRCUIT



If the horn circuit fails, test complete circuit for opens, shorts or high resistance.

1. Check fuse F8. If blown, replace with fuse of the same rating. If fuse blows again, test circuit for a short. Refer to page **12B-4** for information on testing for a short circuit. If fuse is not blown, continue with step 2.
2. Test circuit for an open or high unwanted resistance starting at the load (horn) and working back through the entire circuit. Refer to page **12B-3** for information on testing.

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Chapter 12: Cab Subsystem

Section C Repair

SUMMARY

The Cab subsystem repair consists of standard maintenance, such as:

- replacing air cleaner elements
- checking and replacing compressor belt
- inspecting hoses for wear or damage
- ensuring all hose clamps are tight

Refer to the T655III Trencher *Maintenance Manual* for information.

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Revision History

Revision	Date	Page(s)	Description
S1_00	10/07	All	1st edition manual released.

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