



Pro 300

Service Manual

Models 988089, 090, 310

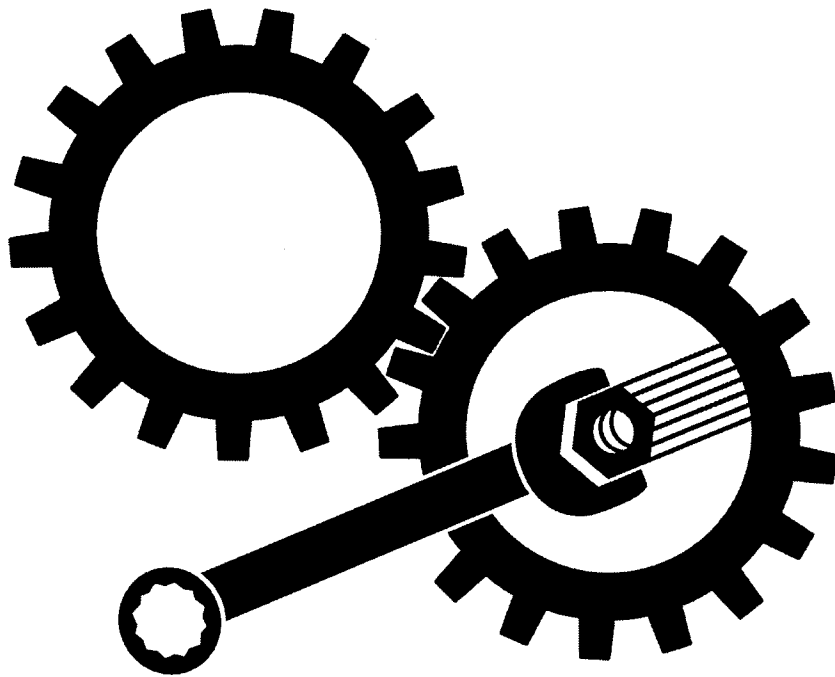


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SECTION 1 - INTRODUCTION

1.1 THE MANUAL

The purpose of this manual is to provide complete instructions for service, maintenance, disassembly, repair, and installation of the mechanical components for the unit.

Dealer trained service personnel should use this manual as a supplement to and reminder of the training sessions conducted by the company.

Read all information for servicing a part or system before repair work is started to avoid needless disassembly.

Operation

Before operation of the unit, carefully and completely read manuals supplied with the unit. The contents will provide you with an understanding of safety instructions and controls during normal operation and maintenance.

Safety Messages

For your safety and the safety of others always read, understand, and follow all DANGER, WARNING, and CAUTION messages found in manuals and on safety decals.

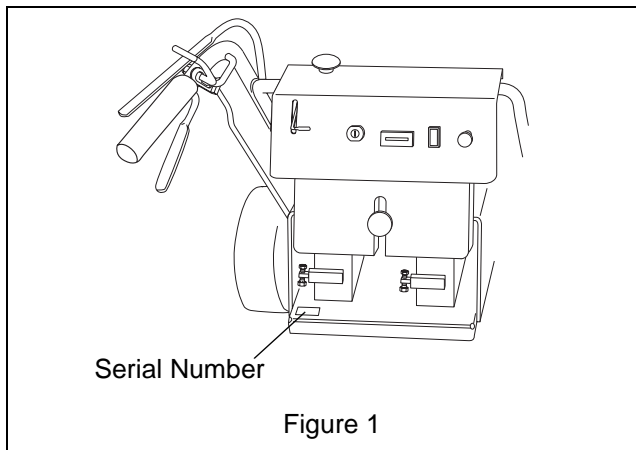
Directional Reference

All reference to left, right, front, or rear are given from the operator in the operator position and facing the direction of forward travel.

1.2 SERVICE AND REPLACEMENT PARTS

When ordering publications, replacement parts, or making service inquiries, know the Model and Serial numbers of your unit and engine.

Numbers are located on the product registration form in the unit literature package. They are printed on a serial number label, located on the frame of your unit.



1.3 PRODUCT REGISTRATION

A warranty registration card must be filled out, signed, and returned at time of purchase. This card activates the warranty. Claims meeting requirements during limited warranty period will be honored.

1.4 UNAUTHORIZED REPLACEMENT PARTS

Use only Gravelly replacement parts. The replacement of any part on this vehicle with anything other than a Gravelly authorized replacement part may adversely affect the performance, durability, or safety of this unit and may void the warranty. Gravelly disclaims liability for any claims or damages, whether warranty, property damage, personal injury, or death arising out of the use of unauthorized replacement parts.

1.5 DISCLAIMER

Gravelly reserves the right to discontinue, make changes to, and add improvements upon its products at any time without public notice or obligation. The descriptions and specifications contained in this manual were in effect at printing. Equipment described within this manual may be optional. Some illustrations may not be applicable to your unit.

1.6 TECHNICAL SERVICE COMMUNICATIONS

Gravelly Technical Service communicates information to the field using Service Letters, Service Bulletins, Product Notices, and Campaigns. Each communication signifies a type of information and priority. The dealer is responsible to carry out the directive provided in the communication. The types of communication are:

Service Letter - General technical information for the dealer. Technical information on how to service the product and product improvements.

Service Bulletin - Notification to update products to resolve certain issues or a notification of a policy change.

Product Notices - Notification of limited product located in a certain region. This is a limited distribution to only those who received the product involved.

Campaigns - Notification of a safety related issue. All products must be updated and are tracked by the factory until all units are corrected.

1.7 PREPARATION

Before starting any removal of parts, proper preparation is very important for efficient work. A clean work area at the start of each job will allow you to perform service repairs easily and quickly.

To reduce the incidence of misplaced tools or parts, place removed components with all attaching hardware in the disassembly order on a clean work surface. Organization is a key part of proper reassembly.

Tools, instruments, and parts needed for the job should be gathered before work is started. Interrupting a job to locate tools or parts is a needless delay.

SECTION 2 - SAFETY

2.1 SAFETY ALERTS



Look for these symbols to point out important safety precautions. They mean:



Attention!
Personal Safety Is Involved!
Become Alert!
Obey The Message!

2.2 SIGNAL WORDS

The safety alert symbol is used in decals on the unit and with proper operation procedures in this manual. They alert you to the existence and relative degree of hazards.

Understand the safety message. It contains important information about personal safety on or near the unit.



DANGER: IMMINENTLY HAZARDOUS SITUATION! If not avoided, WILL RESULT in death or serious injury.



WARNING: POTENTIALLY HAZARDOUS SITUATION! If not avoided, COULD RESULT in death or serious injury.



CAUTION: POTENTIALLY HAZARDOUS SITUATION! If not avoided, MAY RESULT in minor or moderate injury. It may also be used to alert against unsafe practices.

2.3 NOTATIONS

NOTE: General reference information for proper operation and maintenance practices.

IMPORTANT: Specific procedures or information required to prevent damage to unit or attachment.

2.4 PRACTICES AND LAWS

Practice usual and customary safe working precautions, for the benefit of yourself and others. Understand and follow all safety messages. Be alert to unsafe conditions and the possibility of minor,

moderate, or serious injury or death. Learn applicable rules and laws in your area.

2.5 REQUIRED OPERATOR TRAINING

Original purchaser of this unit was instructed by the seller on safe and proper operation. If unit is to be used by someone other than original purchaser; loaned, rented or sold, ALWAYS provide the Operator's Manual and any needed safety training before operation.

2.6 PREPARATION

Before starting any removal of parts, proper preparation is very important for efficient work. A clean work area at the start of each job will allow you to perform service repairs easily and quickly.

To reduce the incidence of misplaced tools or parts, place removed components with all attaching hardware in the disassembly order on a clean work surface. Organization is a key part of proper reassembly.

Tools, instruments, and parts needed for the job should be gathered before work is started. Interrupting a job to locate tools or parts is a needless delay. A list of required special tools has been included in this manual.



CAUTION: Remove enough fuel so that no spillage will occur. Remove battery to prevent spillage of electrolyte.

2.7 CLEANING AND STORAGE

IMPORTANT: Never spray unit with water or store unit outdoors to help prevent sealed bearing rust or corrosion. Water can seep into sealed bearings and reduce component life. Bearings are sealed against dirt and debris only.

A unit that is excessively dirty should be cleaned before work starts. Cleaning will occasionally uncover trouble sources. Dirt and abrasive dust reduce the efficient work life of parts and can lead to costly replacement.

When taking unit out of extended storage:

1. Check for any damage or loose parts. Repair, replace, or tighten hardware before operation.

2. If a preservative fluid was used in fuel tank, drain and discard. Fill fuel tank with fresh new fuel.

2.8 SAFETY RULES

Walk Around Inspection

Complete a walk around inspection of unit and work area to understand:

- Work area.
- Your unit.
- All safety decals.

Work Area

ALWAYS check overhead and side clearances carefully before operation. ALWAYS be aware of traffic when operating along streets or curbs.

ALWAYS keep hands and feet within the limits of the unit.

Keep children, people, and animals away. Keep children out of work area and under watchful care of a responsible adult.

Keep area of operation clear of all toys, pets, and debris. Objects can cause vehicle instability and injury.

Check for weak spots on dock, ramps or floors. Avoid uneven work areas and rough terrain. Stay alert for hidden hazards.

DO NOT run engine in an enclosed area. Always provide good ventilation.

Unit

ALWAYS keep protective structures, guards, and panels in good condition, in place and securely fastened. NEVER modify or remove safety devices.

Check Safety Interlock System for proper operation daily (see Operation section). Do not operate unless system operates properly.

Operation

Understand:

- How to operate all controls
- The functions of all controls
- How to STOP in an Emergency
- Speed ranges

Do not operate any of the control levers or power take-off unless both feet are resting on the platform.

DO NOT travel at too fast a rate. DO NOT change engine governor settings or over-speed engine.

Always back up slowly. Always look down and behind before and while backing.

Never leave a running unit unattended. ALWAYS shut off power take off, lower throttle setting, and stop engine before leaving unit. ALWAYS remove key to prevent unauthorized use.

Never carry passengers on any part of unit.

Avoid uneven and rough terrain. DO NOT operate near drop offs, ditches, or embankments. Unit can suddenly turn over if a wheel is over the edge of a cliff or ditch, or if an edge caves in.

If tires lose traction, turn off power take off and proceed slowly straight down slope. Avoid wet surfaces.

Avoid parking on a slope. If necessary, use wheel chocks.

DO NOT leave unit unattended on a slope. ALWAYS use wheel chocks when leaving unit.

ALWAYS operate unit in good visibility and light.

Fuel is highly flammable and its vapors can explode. Use ONLY approved fuel containers.

NO Smoking!

NO Sparks!

NO Flames!

Allow engine to cool before servicing.

NEVER fill fuel tank when engine is running, hot, or unit is indoors.

Abnormal Vibrations are a warning of trouble. Striking a foreign object can damage unit. Immediately stop unit and engine. Remove key and wait for all moving parts to stop. Remove wire from spark plug. Inspect unit and make any necessary repairs before restart.

Hazardous Slopes

DO NOT operate on steep slopes. Avoid operating on slopes. When you must operate on a slope, travel up and down the slope. Never operate across a slope. Never operate on a slope greater than 10 degrees.

Child Safety

NEVER allow children to operate or play on or near unit. Be alert and shut off unit if children enter area.

Personal Safety

Read and obey all warning, caution, and instructions on the unit and in provided manuals.

- Only trained adults may operate unit.
- Training includes actual operation.
- Clearly understand instructions.
- Be alert! Conditions can change.

NEVER operate unit after or during the use of medication, drugs or alcohol. Safe operation requires your complete and unimpaired attention at all times.

NEVER allow anyone to operate the unit when their alertness or coordination is impaired.

DO NOT operate unit without wearing adequate outer garments. Wear adequate safety gear and protective gloves. Wear proper footwear to improve footing on slippery surfaces.

Protect eyes, face, and head from objects that may be thrown from unit. Wear appropriate hearing protection.

Avoid Sharp Edges. Sharp edges can cut. Moving parts can cut or amputate fingers or a hand. Wear gloves to service unit when handling sharp edges.

ALWAYS keep hands away from any pinch points.

ALWAYS keep hands and feet away from all moving parts during operation. Moving parts can cut off body parts.

DO NOT touch unit parts which might be hot from operation. Allow parts to cool before attempting to maintain, adjust, or service.

Controls

Come to a complete stop before reversing.

Never jerk the control levers. Always use a steady even action to achieve smooth control.

Always be aware of obstructions that may cause injury to operator or damage to the unit.

Service Position



WARNING: ALWAYS block wheels and know that jack stands or blocks used are stable, strong, or secure and will hold the weight of the unit during maintenance.



WARNING: ROTATING PARTS can amputate body parts. Keep hands and feet away. Loose clothing, long hair or scarves can get caught in rotating parts and cause death or serious injury.

Place unit on flat, level surface. ALWAYS stop engine and disengage clutches. Assure unit is secure and will not tip over. Strap and clamp onto lift, if used.

To ensure the unit is positioned in the proper service position:

1. Place jack stands under rear transaxles only.
2. If jacks are not available, place support blocks under both transaxles at the rear of unit.



CAUTION: Remove enough fuel so that no spills will occur.

Maintenance

ALWAYS maintain unit in safe operating condition. Damaged or worn out muffler can cause fire or explosion.

Check the conditions of the unit at the end of each day and repair any damage or defects.

ALWAYS block wheels and know all jack stands are strong and secure and will hold weight of unit during maintenance.

Keep nuts and bolts tight and keep equipment in safe operating conditions.

Before maintenance, adjustments, or service (except where specifically recommended), shut off engine.

Allow hot parts to cool.

Keep unit free of dirt, stones, and other debris. Clean up oil or fuel spills.

Storage

DO NOT store unit inside a building with fuel in the fuel tank where any ignition sources are present. Allow unit to cool completely.

ALWAYS clean unit before extended storage. See Engine Manual for proper storage.

Spark Arrester

This product is equipped with an internal combustion engine. DO NOT use on or near any unimproved, forest covered or brush covered land unless the exhaust system is equipped with a spark arrester meeting applicable local, state or federal laws. A spark arrester, if used, must be maintained in effective working order by the operator.

Battery

Avoid Electric Shock. DO NOT reverse battery connections.

Explosive Gases! Poisonous battery fluid contains sulfuric acid and its contact with skin, eyes, or clothing can cause severe burns.

No flames. No sparks. No smoking near battery.

Always wear safety glasses and protective gear near battery.

DO NOT TIP battery beyond a 45° angle in any direction.

ALWAYS KEEP BATTERIES OUT OF REACH of children.

Transport

Use extra care when loading or unloading unit onto trailer or truck. Secure unit chassis to transport vehicle. NEVER secure from rods or linkages that could be damaged.

DO NOT transport with attachment in raised position.

Lower attachment when unit is parked or stored unless a positive mechanical lock is used.

Attachments and Accessories

Use only attachments or accessories designed for your unit.

2.9 CLEAN UNIT

Brush grass, dirt and debris off of unit with a soft brush. Clean packed grass out from under mower deck. Apply paint or oil to exposed, bare metal surfaces to prevent rust.

Inspect unit for visible signs of wear, breakage, or damage. Order any parts required and make necessary repairs to avoid delays when beginning use again.

IMPORTANT: Never spray unit with water or store unit outdoors. Water can seep into sealed bearings, which are sealed against dirt and debris only, causing reduced component life.

Clean seat regularly, using a vinyl cleaner (not solvent). Extreme temperatures can damage seat when left unprotected against weather. If seat should tear, apply vinyl repair tape to protect damaged area.

Transaxle cooling fins must be kept clean to prevent damage from overheating. Use a cloth or brush to remove grass, chaff and debris.

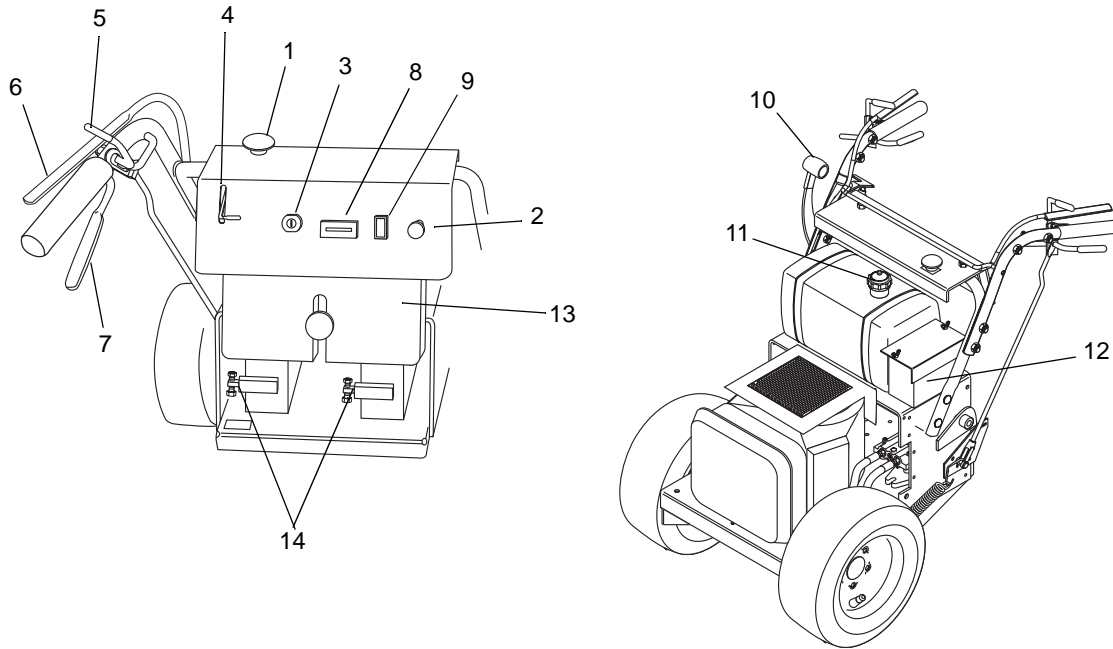
Unless there are indications of leakage, transaxle does not have to be checked for proper oil level. If leak occurs, have it repaired by your Gravely Dealer.

SECTION 3 - SPECIFICATIONS

Model Number	988089	988090	988310
Engine	14 HP	22 HP	14 HP
Engine Spec No.	FC 420V-HS17	EH 65 V	FC 420V-HS17
Manufacturer	Kawasaki	Robin	Kawasaki
Battery	12 Volt	12 Volt	12 Volt
Hour Meter	Standard	Standard	Standard
Brakes	Hydrostatic-Dynamic	Hydrostatic-Dynamic	Hydrostatic-Dynamic
Steering	Lever Control	Lever Control	Lever Control
Turning Radius - in (cm)	0	0	0
Tire Size	16 x 6.5 - 8	16 x 6.5 - 8	16 x 6.5 - 8
Tire Pressure	12-15 psi	12-15 psi	12-15 psi
Fuel and Capacity-gal (L)	Unleaded-4.5 (13.3)	Unleaded-4.5 (13.3)	Unleaded-4.5 (13.3)
Idle RPM.	1550	1600	1550
Governed RPM (No Load)	3300	3300	2900
Crank Case Capacity-pints (L) Oil Filter	4 (1.9) P/N 20777000	4 (1.9) P/N 21527000	4 (1.9) P/N 20777000
Air Cleaner	N/A	P/N 21527400	N/A
Charging Capacity	13 amp	15 amp	13 amp
Fuel Filter	040742	040742	040742
Spark Plug -Type -Gap	Champion RN11YC 0.028-0.031	NGK 0.03	Champion RN11YC 0.028-0.031
Speed - Forward -mph (kph) (max)	5.6 (9)	5.6 (9)	5.6 (9)
Speed - Reverse-mph (kph) (max)	2.4 (3.8)	2.4 (3.8)	2.4 (3.8)
Transmission Lube	Mobil 20W-50 API	Mobil 20W-50 API	Mobil 20W-50 API
Transmission Filter	05096800	05096800	05096800
Traction Belt	05114100	05114100	05114100
PTO Belt	04321300	04321300	04321300
Battery	04135800	04135800	04135800

SECTION 4 - GENERAL MAINTENANCE & ADJUSTMENTS

4.1 CONTROLS AND FEATURES



1. PTO Knob
2. Choke Control
3. Ignition Switch
4. Throttle Lever
5. Steering Lever Latch
6. Operator Presence Controls
7. Steering Lever

8. Hourmeter
9. Oil Light
10. Speed Control Lever
11. Fuel Cap
12. Battery
13. Hydraulic Fluid Tank
14. Bypass Valve Levers

Figure 2

OG0551
OG0541

4.2 FILLING THE FUEL TANK



WARNING: Use caution with fuel. Fuel is very flammable. Keep fuel in a clean and tight container. Keep fuel away from fire and heat. Never put fuel in the fuel tank while the engine is running or hot. Clean up any spilled fuel before starting the engine.

Add fuel to the fuel tank as needed. See your engine manual for the correct type and grade of fuel to be used.

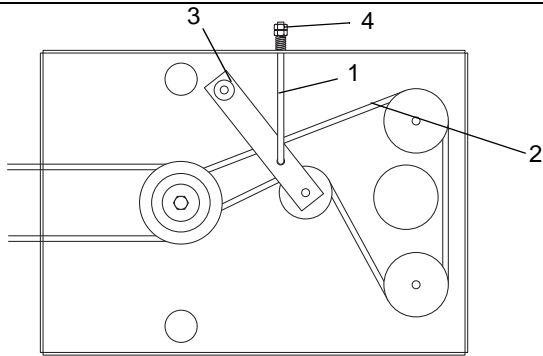
1. Put the unit in an open and well ventilated area prior to refueling.
2. Stop the engine.
3. Allow the engine to cool.
4. Clean the fuel cap and in the area around the fuel cap. Remove the cap from the fuel tank.
5. Fill the fuel tank with the proper grade of fuel recommended by the engine manufacturer. Be careful not to spill any fuel.
6. Install fuel cap on the fuel tank and tighten.
7. Clean up any spilled fuel before starting engine.

4.3 GENERAL LUBRICATION

Apply a small amount of oil to the pivot points as required for smooth and proper operation.

Every 50 hours of operation, apply high quality lithium based grease to the lube fittings, in each of the bushing support weldments.

4.4 TENSIONING THE HYDRO PUMP BELT



- | | |
|--------------------|---------------------------|
| 1. Idler Rod | 3. Belt Tension Idler Arm |
| 2. Hydro Pump Belt | 4. Jam Nuts |

Figure 3

0G0650

4.5 HYDRAULIC FLUID LEVEL

The hydraulic fluid level should be checked daily (more often if leaks are observed).

1. Check hydraulic fluid level by looking at the hydraulic fluid tank. Both sides of the tank should be full to the top of the partition in the tank.

NOTE: Do not allow any dirt to get into the system.

2. Add hydraulic fluid to bring level up to the proper height. See Specifications section for proper type of hydraulic fluid.

The hydraulic oil filter and hydraulic oil should be changed after the first 50 hours. They both should be changed every 500 hours thereafter.

Be sure to stop engine before servicing any hydraulic parts.



WARNING: HYDRAULIC FLUID UNDER PRESSURE can penetrate skin and cause severe burns that can result in death or serious injury.

ALWAYS keep body and hands away from pin holes or nozzles which eject hydraulic fluid under pressure.

ALWAYS use paper or cardboard and not hands to search for leaks.

KNOW that all hydraulic fluid connections are tight and all hydraulic hoses and lines are in good condition BEFORE applying pressure to system.

Foreign fluid injected into skin must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.

4.6 STEERING CONTROL NEUTRAL ADJUSTMENT

If the unit has excessive creep when the speed control lever is in neutral, adjust as follows:

1. Stop the engine.
2. Put the speed control lever in neutral. (This is important.)
3. With the unit facing a wall, jack unit up so that both drive wheels are off the ground.
4. Remove pump override spring.



WARNING: An extension spring, when extended, stores energy and can be dangerous. Always use tools specifically designed for installing or removing an extension spring. Always compress or extend springs slowly.

5. Disconnect the steering control rod clevis, flat washer, and hair pin cotter from the speed control arm (Figure 4).
6. Loosen the top roller on the speed control arm and slide roller away from the speed control cam.
7. Loosen the two 1/4-20 hex bolts holding the neutral adjustment weldment just enough so the weldment can be rotated by tapping on one of the bottom corners with a wrench or small hammer.

8. Start the engine and run at about half throttle or faster.
9. Tap on one bottom corner or the other of the neutral adjustment weldment until the wheel stops turning. Tighten the two 1/4-20 hex bolts.
10. Rotate the speed control arm from forward to reverse several times to make sure it is adjusted to neutral. Readjust if necessary.
11. Stop the engine.
12. Move the top roller in close to the speed control cam and tighten the nut to the point where you can move the roller by tapping on the nut. Now move the roller until it just touches the speed control arm and tighten the nut.
13. Lock the steering control lever in the up position with the steering latch lever and hold there.
14. With a steering lever locked in the up position, adjust the clevis on the steering control rod until the clevis pin is near the high end of the slot in the speed control arm.
15. Install the flat washer and hair pin.
16. Reconnect the pump over-ride spring.
17. Repeat for other side.

4.7 STEERING LEVER ADJUSTMENT

See Figure 4.

1. Follow steps 1 through 4 in the Steering Control Neutral Adjustment section.
2. Remove hair pin cotter and flat washer from clevis pin at the clevis end of the steering control rod.
3. Lock the steering lever in the up position with the steering lever latch and hold there.
4. With the steering lever locked in the up position, adjust the clevis on the steering control rod until the clevis pin is near the high end of the slot in the speed control arm.
5. Install the flat washer and hair pin.
6. Reconnect the pump override spring.
7. Repeat for other steering lever.

4.8 CHECK TIRES

Keep tires properly inflated at all times. The correct air pressure is 12 to 15 psi. After checking and/or inflating, replace and tighten valve caps to prevent air loss.

4.9 ADJUSTING THE UNIT TO TRACK STRAIGHT

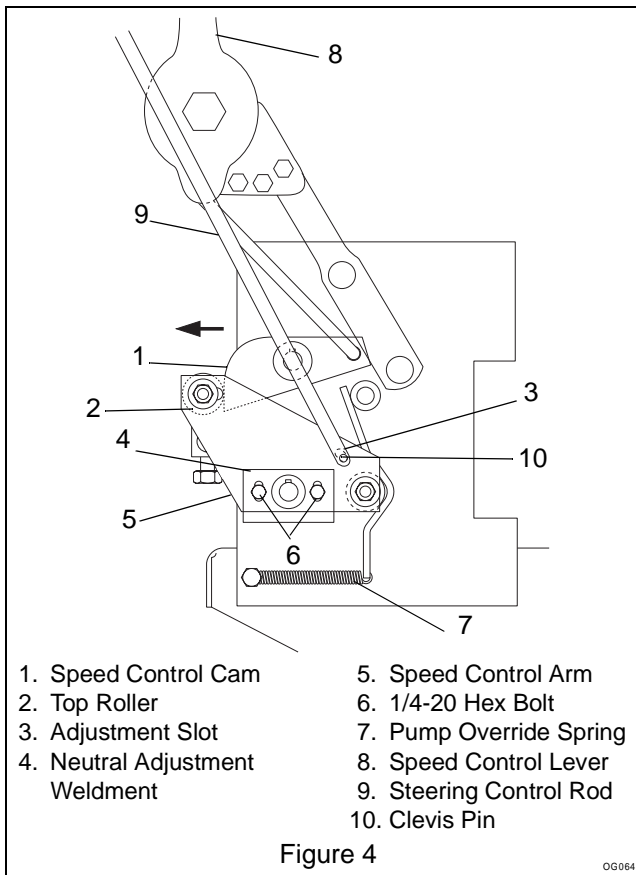
The steering control arm neutral and steering lever adjustments should be within range.

If the unit tends to slowly turn to the right, try each of the following steps until the unit tracks straight. It may not be necessary to perform all the steps listed in order for the unit to operate correctly.

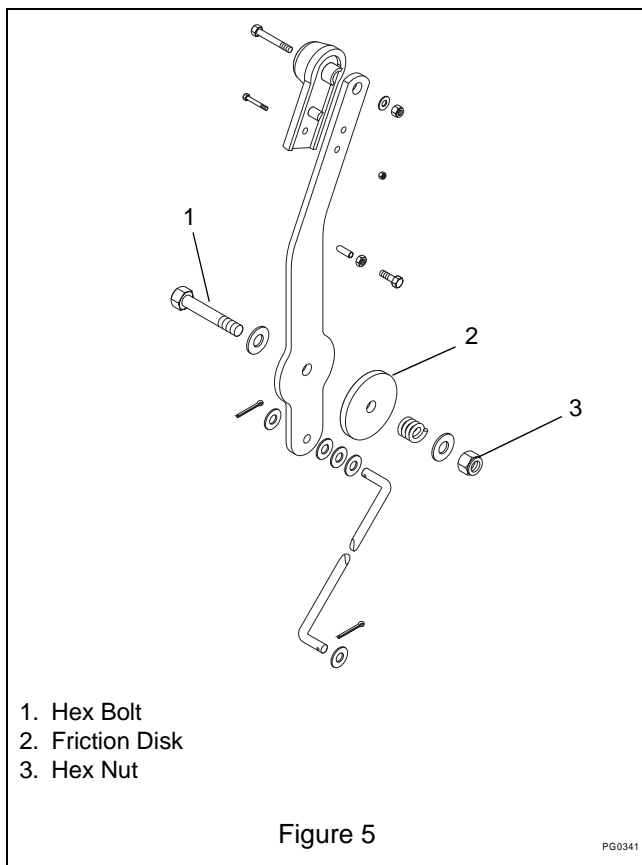
1. Move the right top roller slightly away from the speed control cam.
2. Move the left top roller tighter against the speed control cam.
3. Reduce the air pressure in the left tire.
4. Increase the air pressure in the right tire.

If the unit tends to slowly turn to the left, try each of the following steps until the unit tracks straight. It may not be necessary to perform all the steps listed in the order for the unit to operate correctly.

1. Move the left top roller slightly away from the speed control cam.
2. Move the right top roller tighter against the speed control cam.
3. Reduce the air pressure in the right tire.
4. Increase the air pressure in the left tire.



Adjusting the friction of the speed control lever is accomplished by tightening or loosening the 3/4" bolt and nut that attaches the control lever to the hand bar bracket (Figure 5). Adjust the speed control lever to the comfort of the operator, but insure there is enough friction (pressure) on the friction disc to hold the speed control lever in the desired position.



SECTION 5 - ENGINE

5.1 ENGINE TROUBLESHOOTING

The following troubleshooting chart is to be used to isolate engine problems and give possible causes and corrective action responses.

The troubleshooting key is generic and can be used for several types of engines. Use only those possible causes and corrective actions that apply to the unit.

TROUBLE	POSSIBLE CAUSES (Refer to Key Below)	CORRECTIVE ACTION
Black Exhaust	1, 20, 22, 25, 29, 31, 32, 33	repair or replace
Blue/White Exhaust	4, 20, 25, 31, 33, 34	repair or replace
Difficult Starting	1, 5, 7, 8, 9, 10, 20, 21, 22, 29, 31, 32, 33	repair or replace
Erratic Running	1, 7, 8, 9, 10, 20, 21, 23, 26, 29, 33, 59, 62	repair or replace
Excessive Fuel Consumption	1, 20, 22, 23, 25, 29, 31, 32, 33	repair or replace
Excessive Crankcase Pressure	25, 31, 33, 34, 45, 55	
High Oil Pressure	4, 41	repair or replace
Knocking	22, 26, 29, 31, 33, 36, 46, 59	repair or replace
Loss of Power or System	1, 8, 10, 20, 21, 22, 23, 25, 26, 31, 32, 33	repair or replace
Low Cranking Power	2, 3, 4, 11	repair or replace
Low Oil Pressure	4, 36, 37, 39	repair or replace
Misfiring	10, 20, 25, 26, 28, 29, 32	repair or replace
Overheating	1, 19, 25,	repair or replace
Poor Compression	25, 28, 29, 31, 32, 33, 34, 59,	repair or replace
Starts and Stops	1, 6, 10, 62	repair or replace see electrical systems see engine service manual
Vibration	20, 23, 25, 26, 29, 33, 45, 49	repair or replace
Will Not Crank	2, 11, 45	charge battery or replace
Will Not Start	1, 10, 62	repair or replace see electrical systems see engine service manual

TROUBLESHOOTING KEY					
1	Restriction in air cleaner	22	Incorrect grade of fuel	43	Faulty suction pipe
2	Bad electrical connection	23	Sticking throttle/restricted movement	44	Choked oil filter
3	Faulty starter motor	24	Exhaust pipe restriction	45	Bad solenoid switch
4	Incorrect grade of lubricating oil	25	Leaking cylinder head gasket	46	Incorrect piston height
5	Low cranking speed	26	Overheating	47	Damaged fan
6	Fuel tank empty	27	Cold running	48	Faulty engine mounting
7	Controls not in correct operation position	28	Incorrect tappet adjustment	49	Incorrectly aligned flywheel and/or flywheel housing
8	Blocked fuel feed line	29	Sticking valves	50	Faulty thermostat
9	Faulty fuel lift pump	30	Incorrect high pressure pipes	51	Restriction in water jacket
10	Choked fuel filter	31	Worn cylinder bores	52	Loose fan belt
11	Battery capacity low	32	Pitted valves and seats	53	Choked radiator
12	Air in fuel system	33	Broken, worn or sticking piston ring(s)	54	Faulty water pump
13	Faulty fuel injection pump	34	Worn valve stems and guides	55	Choked breather pipe
14	Faulty fuel injectors or incorrect type	35	Restriction in air cleaner	56	Damaged valve stem oil deflector (if fitted)
15	Incorrect use of cold start equipment	36	Worn or damaged bearings	57	Coolant level too low
16	Faulty cold start equipment	37	Insufficient oil in sump	58	Blocked sump strainer
17	Broken fuel injection pump drive	38	Bad/defective oil temperature switch	59	Broken valve spring
18	Incorrect fuel pump timing	39	Oil pump worn	60	Exhaust or vacuum pipe leak
19	Incorrect valve timing	40	Pressure relief valve sticking open	61	Bad or defective water temperature switch
20	Poor compression	41	Pressure relief valve sticking closed	62	Bad spark plug(s)
21	Blocked fuel tank vent	42	Broken relief valve spring		

5.2 CHECKING ENGINE OIL

Check the engine oil BEFORE EACH USE OR TWICE DAILY ON COMMERCIAL USE as follows.

5.3 CHANGING OIL FILTER

Some engines are equipped with an oil filter. Replace the oil filter every other oil change, referring to *Oil Change Intervals*. See engine manufacturers manual for proper intervals and oil type.

5.4 AIR CLEANER

This engine is equipped with a replaceable, high density paper air cleaner element. Some engines are also equipped with an oiled, foam precleaner which surrounds the paper element.

5.5 CHECK SPARK PLUG

Every 100 hours or operation, remove the spark plugs, check condition, and reset gaps or replace with new plugs as necessary.

1. Before removing spark plugs, clean the area around base of plugs to keep dirt and debris out of the engine.
2. Remove plugs and check condition. Replace plugs if worn or reuse is questionable.

NOTE: Do not clean the spark plug in a machine using abrasive grit. Some grit could remain in the spark plug and enter the engine causing extensive wear and damage.

5.6 ENGINE REMOVAL AND INSTALLATION

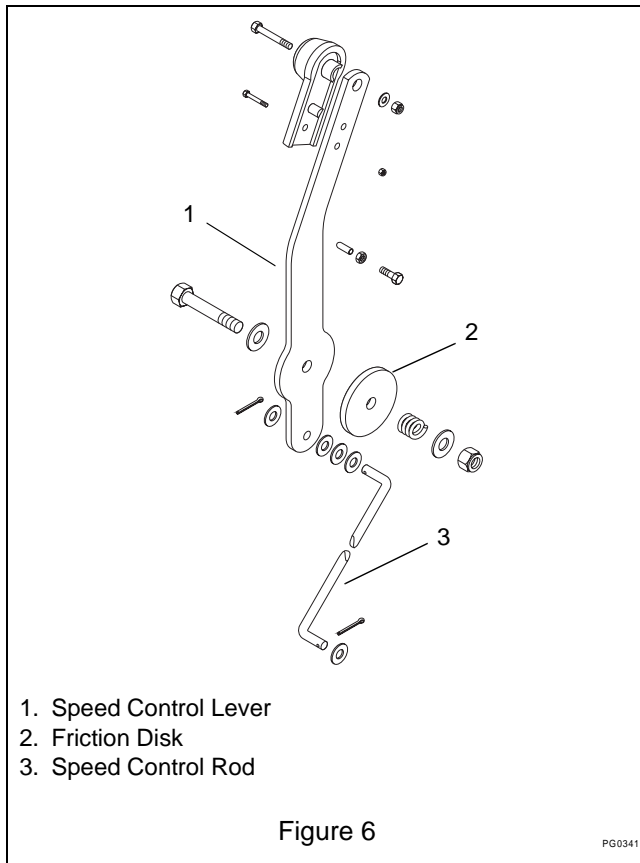
1. Remove the battery cover and disconnect battery cables. Remove negative cable first. Remove the battery.
2. Turn off fuel at fuel tank shut-off valve and disconnect the fuel line at the engine filter.
3. Disconnect the choke and throttle cables.
4. Disconnect the wiring harness at engine, starter cable, battery ground cable, engine ground wires, and oil sensor wire.

NOTE: After disconnecting the engine ground and battery ground, replace the lift bracket to hoist the engine.

5. Loosen the tension on the PTO clutch and hydro pump belts and remove belts from the engine sheaves.
6. Disconnect the hydraulic cooler bracket from the frame and hang over the right wheel. Take care not to damage the cooling fins.
7. Lift engine out.
8. The engine is replaced in reverse order.

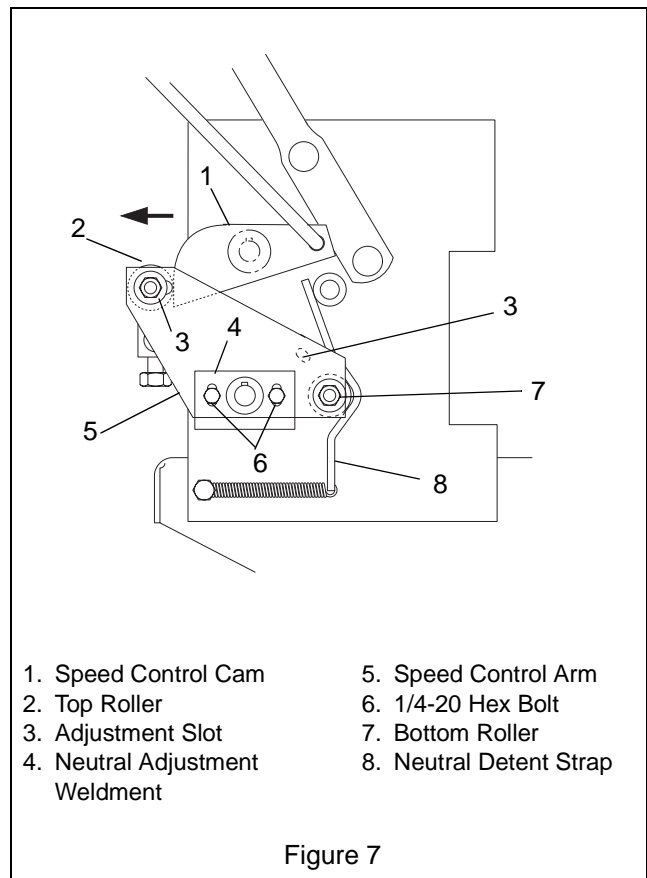
SECTION 6 - STEERING & CONTROLS

6.1 SPEED CONTROL LEVER



1. Remove the cotter key and washer from the speed control actuating rod. Slide the rod out of the speed control lever.
2. Remove the 3/4" nut, washer, and compression spring from bolt.
3. Pull out the bolt and remove the speed control lever and friction disc.
4. Inspect and replace any worn or damaged parts.
5. Reverse the disassembly procedure to reassembly.
6. Insure that the speed control lever safety switch functions properly before operating the power unit.

6.2 SPEED CONTROL CAM

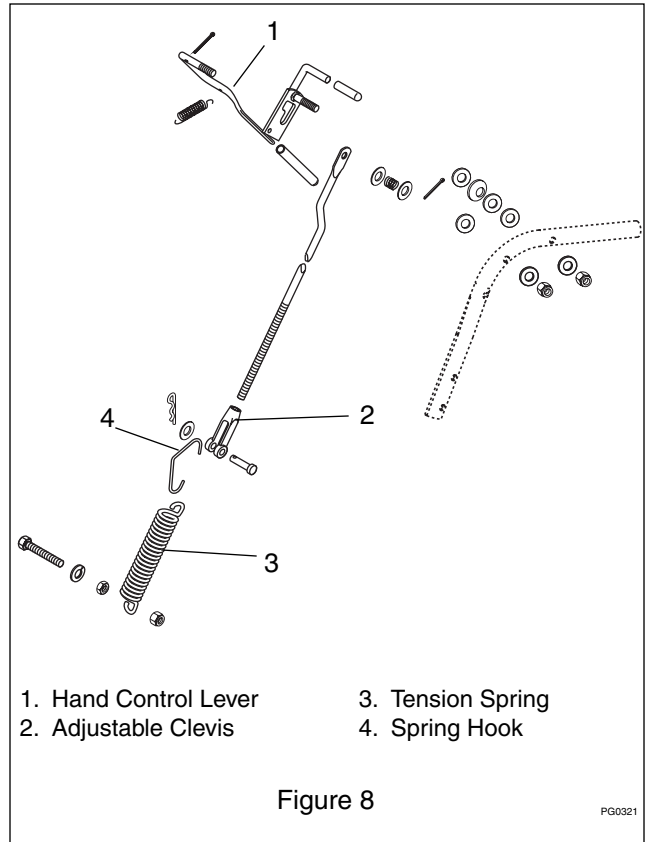


1. Remove the left and right pump override springs and spring hooks. Note orientation of hooks.
2. Remove the cotter key and washer from the speed control actuating rod and slide it out of the speed control cam. Take notice of the orientation of the five washers.
3. Loosen the 7/16" bolt and slide the control cam off of the speed control cam shaft. Remove the woodruff key if the pump control weldment is to be removed.
4. Inspect and replace any worn or damaged parts.
5. Repeat on the opposite side if needed.
6. Reverse the disassembly procedure to reassemble. When attaching the spring hooks, make sure that the long side is up. See Figure 8.
7. Refer to sections on *Neutral Adjustments* and *Adjusting the Unit to Track Straight*.

6.3 SPEED CONTROL ARM AND DETENT STRAP

1. Remove the pump override spring, neutral detent spring and disconnect the steering control rod.
2. Loosen the 7/16" bolt at the rear of the speed control arm and slide off the pump control shaft. Remove the woodruff key if the pump control shaft is to be removed.
3. Remove the two 7/16" bolt and nuts from the neutral adjustment plate to separate it from the speed control arm.
4. Remove the detent strap by removing the 9/16" bolt and nut.
5. Inspect and replace any worn or damaged parts. Be sure that the two nylon rollers spin free and are smooth on the outside. If grooved, replace them.
6. Repeat on the opposite side if needed.
7. Reverse the disassembly procedure to reassemble.
8. Grease the flange support bushing and check for binding.

6.4 STEERING CONTROL



1. Place the hand control lever in position to relax the tension spring.
2. Remove the clevis pin. Be cautious regarding the spring tension on the clevis pin.
3. Inspect all parts for wear and replace as needed.
4. Stretch the spring to place the spring hook into the clevis. Replace the pin.

SECTION 7 - DRIVE TRAIN

7.1 TRANSMISSION TROUBLESHOOTING

The following troubleshooting chart is to be used to isolate hydro transmission problems and give possible causes and corrective action responses.

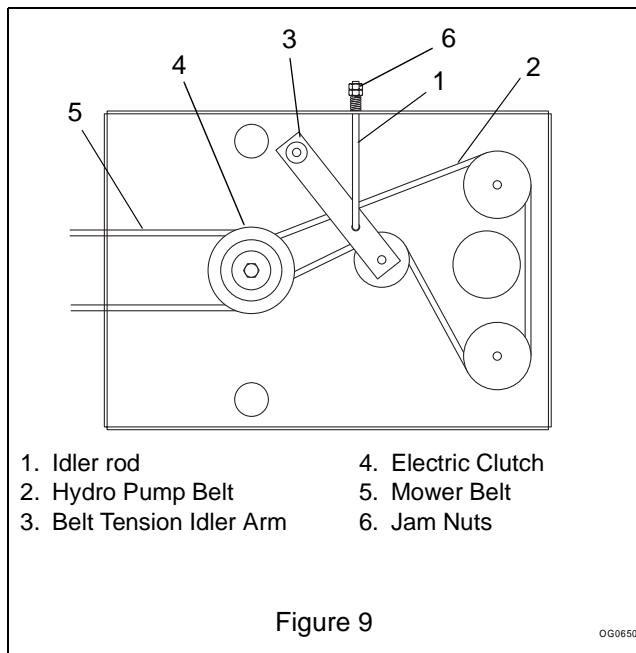
The troubleshooting key is generic and can be used for several types of transmissions. Use only those possible causes and corrective actions that apply to the unit.

TROUBLE	POSSIBLE CAUSES (Refer to Key Below)	CORRECTIVE ACTION
Axles Will Not Turn	1, 7, 8, 12, 16, 18, 28, 32, 38, 42, 46	repair or replace
Difficult Starting	1, 6, 7, 8, 12, 16, 25, 26, 28, 38, 42, 46	repair or replace
Erratic Running	1, 4, 6, 7, 8, 12, 18, 25, 26, 28, 42, 46, 55	repair or replace
Jerky When Starting	1, 4, 7, 8, 12, 18, 28, 38, 46	
Jumps Out of Gear	N/A	repair or replace
Knocking	4, 8, 12, 18, 28, 37, 42	repair or replace
Loss of Power or System	4, 12, 18, 28, 37, 42, 46	
Noisy	4, 12, 18, 26, 28, 32, 37, 42	repair or replace
Oil Leakage	4, 22, 51, 16	repair or replace
Operates Hot	4, 16, 28, 32, 35, 42	
Operates in One Direction Only	1, 8, 12, 30, 46	
Pump Failure	4, 12, 37	repair or replace
Speed Loss Under Load	1, 6, 11, 28, 37, 46, 51	repair or replace
Speed Loss Under Load	1, 4, 7, 12, 18, 28, 26	repair or replace
Will Not Drive	1, 7, 8, 18, 28, 37, 38, 46, 48	
Will Not Shift		repair or replace

TROUBLESHOOTING KEY					
1	Inspect control linkage	22	Inspect hoses and lines for wear	43	Burrs on gearing
2	Inspect acceleration valves	23	Inspect implement relief valve	44	Gears improperly installed
3	Inspect charge check valves	24	Inspect charge pump	45	Forks & rod assembly incorrectly installed
4	Incorrect grade of lubricating oil	25	Bad transmission pump	46	Shifting keys broken or damaged
5	Low cranking speed	26	Overheating	47	Shifting washer in backwards
6	Controls not in correct operation position	27	Cold running	48	Shifter/Brake shaft keyways damaged
7	Belts are missing, too tight, loose or glazed	28	Bad transmission motor	49	Unit clutch not disengaging
8	Overload of vehicle	29	Check system pressure	50	Shifter stop assembled backwards
9	Replacement parts damaged	30	Shift rod grooves worn	51	Improper fit of case to cover
10	Replacement parts improperly installed	31	Reverse chain broken	52	Dowel pins not installed
11	Improperly torqued attaching screws	32	Damaged cooling fan	53	Differential bevel gears broken
12	Air in hydraulic system	33	Inspect auxiliary relief valve	54	Spring in shifter weak or broken
13	Broken shifter stop	34	Inspect cooling fan	55	Worn or stripped gear teeth
14	Inspect charge check valves	35	Inspect transmission cooling fins	56	
15	Inspect acceleration valves	36	Worn or damaged bearings	57	
16	Check oil level-gear box sump or reservoir	37	Metallic pieces or foreign objects in unit	58	
17	Inspect heat exchanger	38	Inspect for loosely mounted components	59	
18	Inspect by-pass valve	39	Steering column loose or binding	60	
19	Inspect charge pressure	40	Pressure relief valve sticking open	61	
20	Inspect inlet filter	41	Pressure relief sticking closed	62	
21	Inspect charge relief valve	42	Broken relief valve spring		

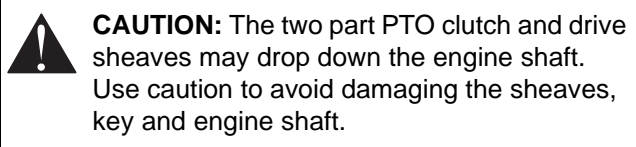
7.2 REPLACING THE HYDRO PUMP BELT

1. Put the speed control lever in the neutral position.
2. Remove the mower belt from the mower clutch sheave.
3. Remove the two jam nuts, flat washer and spring from the idler rod which is used to tension the pump belt.
4. Loosen the 1/2-13 x 3.00 hex bolt holding the belt tension idler arm to the frame.
5. Remove the old belt and install the new belt. Tighten the 1/2-13 x 3.00 hex bolt.
6. Install the spring, flat washer, and jam nuts on the idler rod and tension the belt.
7. Put the mower belt back on the mower clutch sheave.
8. Tighten the belt.



7.3 PTO CLUTCH REMOVAL

1. Loosen the tension on the PTO and hydro pump drive belts. Remove belts from the engine sheaves.
2. Block back of unit and remove mower deck. With deck removed, lower rear of machine to floor. This will make it much easier to remove the PTO.
3. Use caution and remove the 5/8" bolt holding the PTO clutch in place.



7.4 PTO BEARING REMOVAL AND INSTALLATION

1. Separate the 2 clutch halves. Press the bearing out from the inside of sheave.
2. Inspect and replace any worn or damaged parts.
3. Turn sheave upside down and press in new bearing.

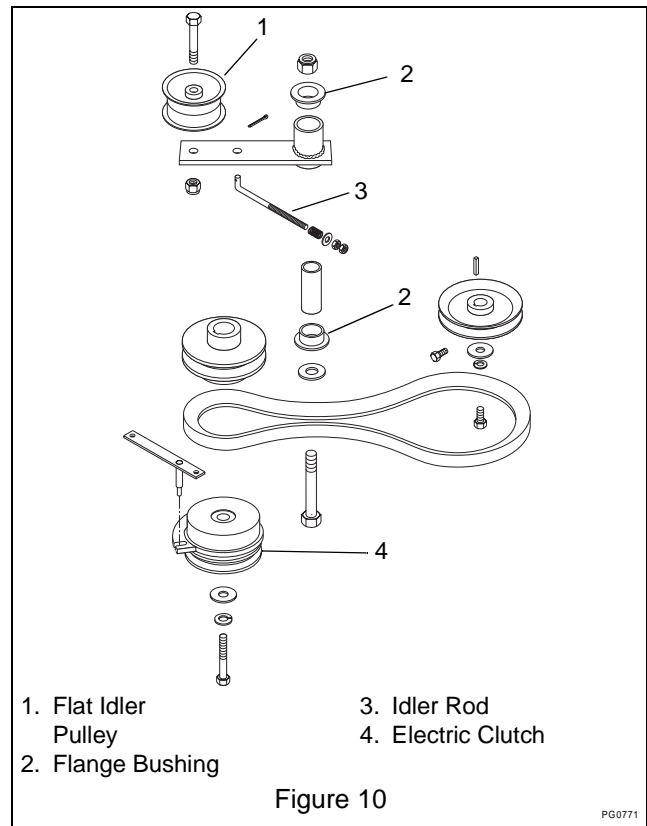
7.5 PTO CLUTCH INSTALLATION

Reverse the disassembly procedure to reassemble.

NOTE: Coat engine shaft with an anti-seize for easier PTO clutch installation and future clutch removal.

7.6 TRACTION CLUTCH

The unit is driven by two hydraulic motors, one on each wheel. These motors are in turn driven by a pump powered by the engine.

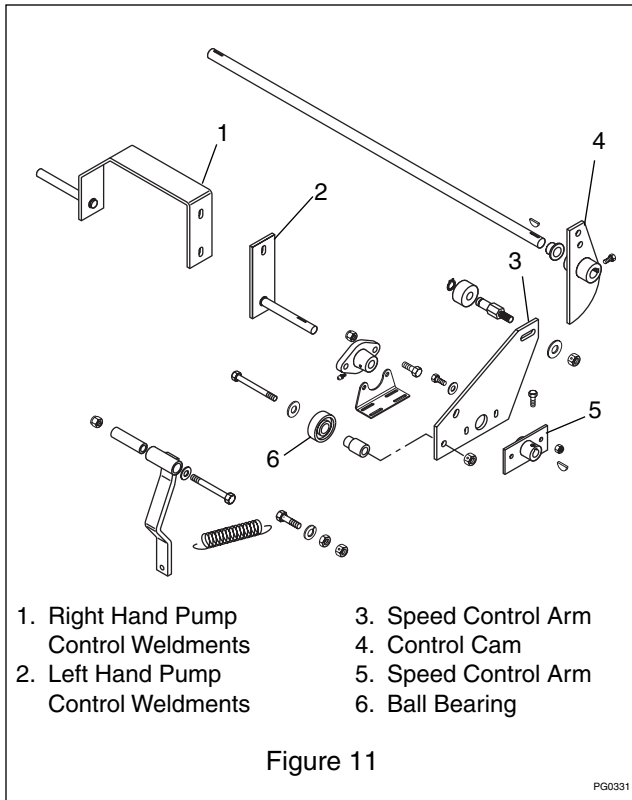


Idler Pulley

To remove the idler pulley:

1. Loosen the two jam nuts on the idler rod enough to remove the belt.
2. Loosen and remove the hex bolt that holds the idler arm.
3. Inspect the bushings for wear and replace if needed.
4. Inspect the pulley for wear.
5. Reassemble in reverse order.

Wheel Drive Linkage

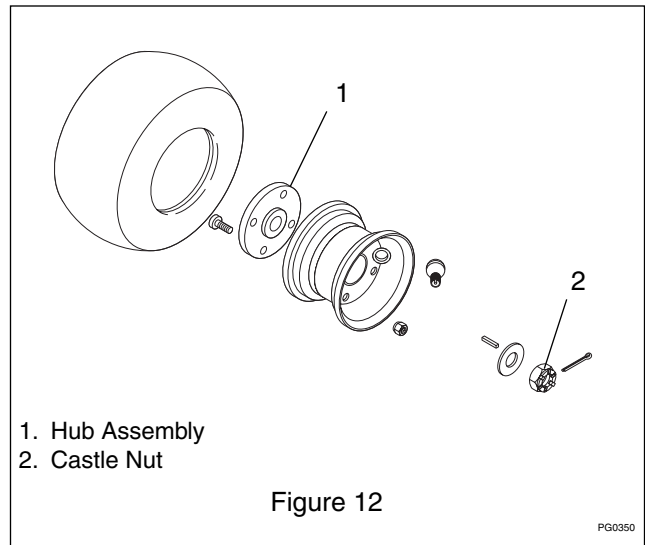


The linkage controls the variable pumps for the wheel motors. This can be disassembled and inspected for wear. Pump control weldments should be greased when reassembled.

7.7 WHEEL AND HUB REMOVAL

1. With the unit against a wall, jack the rear of the unit to raise the wheels off the ground. Use caution not to jack against the hydraulic filter.
2. Remove the four lug nuts holding the rim to the hub.
3. Remove the cotter key and loosen the castle nut a couple of turns.
4. Use a gear puller to pull the hub loose from the tapered shaft. Remove the castle nut and washer. Slide hub off.
5. Inspect hub taper, woodruff key and tapered shaft for any wear or damage. Replace as needed.

7.8 WHEEL INSTALLATION



NOTE: Use steel wool or fine sandpaper to remove any rust or paint from the motor shaft taper or wheel bore taper.

1. Mark end of shaft to indicate where cotter key hole is located.
2. Install woodruff key and slide hub on shaft.
3. Install the washer and castle nut.
4. Using a torque wrench tighten the castle nut to 130 ft-lbs (176 Nm). Stop and check for line up of castle nut and cotter key hole. If needed, increase the torque to line up the hole.



CAUTION: It is not recommended to torque castle nut over 150 ft-lbs (203 Nm). NEVER LOOSEN CASTLE NUT TO ALIGN HOLE.

5. Install cotter key, wheel and lug nuts.
6. Check the tire pressure.

SECTION 8 - FUEL SYSTEM

8.1 FUEL SYSTEM TROUBLESHOOTING

The following troubleshooting chart is to be used to isolate fuel system problems and give possible causes are corrective action responses

The troubleshooting key is generic and can be used for several types of transmissions. Use only those possible causes and corrective actions that apply to the unit.

TROUBLE	POSSIBLE CAUSES (Refer to Key Below)	CORRECTIVE ACTION
Hard Starting	1, 3, 4, 6, 11, 12, 14, 16, 17, 18	clean, repair or replace
Fuel Leak at Carburetor	5, 7, 17	repair or replace
Engine Floods	5, 15, 17	repair or replace
Will not idle	1, 2, 3, 6	repair or replace
Rich idle	1, 6, 14	repair or replace
idles with Needle Closed	14	repair or replace
Hunts Erratic Idle	2, 3, 6, 7, 12, 13, 14, 15, 18	repair or replace
Idles Fast Lean	2, 3, 7	repair or replace
Will Not Accelerate	1, 6, 11, 12, 14, 15, 16	repair or replace
Over Rich Acceleration	1, 15	repair or replace
Hesitates	2, 6, 11, 12, 16	repair or replace
Will Not Run at High Speed	1, 11, 12, 14, 16	repair or replace
Low Power	1, 3, 11, 14, 15, 16, 17, 18	repair or replace
Hunts at High Speed	3, 6, 7, 12, 14, 15, 16, 18	repair or replace
Runs With Needle Closed	14	repair or replace
Engine Overspeeds	2, 3, 7, 14	repair or replace

TROUBLESHOOTING KEY	
1	Plugged Air Filter
2	Leaky Carburetor Gasket
3	Throttle or Choke Shaft Worn
4	Choke Not Functioning Properly
5	Plugged Atmospheric Vent
6	Air Bleed Restricted
7	Damaged or Leaky "O" Rings
8	Damaged Diaphragm
9	Stuck or Dirty Ball Check
10	Diaphragm Upside Down
11	Plugged Tank or Vent
12	Fuel Pick-up Restricted
13	Idler Port Restricted
14	Damaged Adjustment Needle and Seat
15	Incorrect Float Height
16	Main Nozzle Restricted
17	Dirty, Stuck Needle and Seat
18	Fuel Inlet Plugged

8.2 FUEL PUMP

The impulse style fuel pump is the most commonly used fuel pump. Impulse fuel pumps may either be mounted externally onto the carburetor fuel inlet or remotely mounted. These pumps are connected in the fuel line between the fuel supply and the carburetor or directly to the fuel inlet.

Impulse fuel pumps are operated by crankcase impulses created by the up and down movement of the piston. A hose called a pulse line connects the fuel pump diaphragm chamber and transmits the impulses to the pump diaphragm. The impulses actuate the diaphragm and the flap valves to lift the fuel from the fuel tank to the carburetor.

8.3 FUEL SYSTEM CONTAMINATION

Any time fuel contamination is found in the fuel system (dirt, water algae, etc.) replace the fuel, fuel filter and flush the fuel lines. Remove the carburetor bowl and clean. Replace all items that cannot be cleaned. Reassemble the fuel system and check for proper operation.

8.4 FUEL TANK

The fuel tank is made of composite material for long life without breaking down from the additive used in today's blended fuels.

SECTION 9 - HYDRAULIC SYSTEM

IMPORTANT: Change the oil, oil filter, and "run-in" the unit after any hydraulic work is performed to insure proper lubrication and system bleed, to prevent damage to the pumps and motors.

9.1 RUN-IN PROCEDURE

1. After maintenance is performed, set unit against a wall and jack the drive wheels off the ground. Use caution not to jack against the hydraulic filter.
2. Start unit and let run at the idle speed for 1 to 2 minutes to insure proper bleeding of hydraulic pumps.
3. Next run throttle to halfway and speed control arm forward 1/3 travel, let run for 3 to 5 minutes to insure proper bleeding of hydraulic motors.

NOTE: It may be necessary to start the motors turning by hand.

4. Shut off the unit and let down jack.

NOTE: In the course of operating the unit, if any squealing noise from motors occurs, repeat the run-in procedure.

9.2 HYDRAULIC FLOW

NOTE: The only high pressure lines are the four lines between the pumps and motors. The only pressure check would be to plumb in on one of the lines, and run under normal circumstances. The pressure should read approximately 400 psi. See Figure 13.

9.3 FILTER CHANGE

NOTE: Be sure to replenish the oil system with clean, fresh oil.

1. Place open container under filter. The container should be able to hold at least 4 quarts of oil.
2. Clean around filter and turn filter counterclockwise to remove. Let system drain sufficiently.

NOTE: Not all oil will drain.

3. Replace filter with a new Gravelly filter to insure proper oil filtering.
4. Apply a thin coat of oil to seal on filter, and hand tighten filter securely.
5. Refer to *Hydraulic System Run-In Procedure*.

9.4 HYDRAULIC HOSES

IMPORTANT: When loosening any hydraulic hoses, use the correct wrench. If hoses are to be disconnected at a fitting, use two wrenches, one on the hose and one on the fitting. This prevents twisting off the fitting.

1. When working on hoses, have a container large enough to hold at least 4 qts of oil. Some hoses will

drain one side of the hydraulic tank and/or oil cooler.

2. After any hydraulic hose maintenance, refer to *Filter Change and Run-In Procedure* sections.

9.5 HYDRAULIC TANK REMOVAL AND INSTALLATION

1. Place an open-top container that will hold at least 4 quarts of oil under the drain cock of tank. Drain right side.
2. Move container under filter and remove.
3. Clean and remove the two hydraulic hoses from the tank. Cap off hoses to prevent contamination of system.
4. Remove the 1/2" nut, bolt and washer holding tank in place.
5. Slide the bottom of the tank to the rear to remove.
6. Inspect the tank, hose ends, clamps, fittings, and drain cock. Look for worn or damaged parts and replace as needed.

IMPORTANT: Use a teflon pipe sealant when replacing any fittings. Tighten down until seated flush. DO NOT OVERTIGHTEN. Over-tightening can cause the tank to split at the seam.

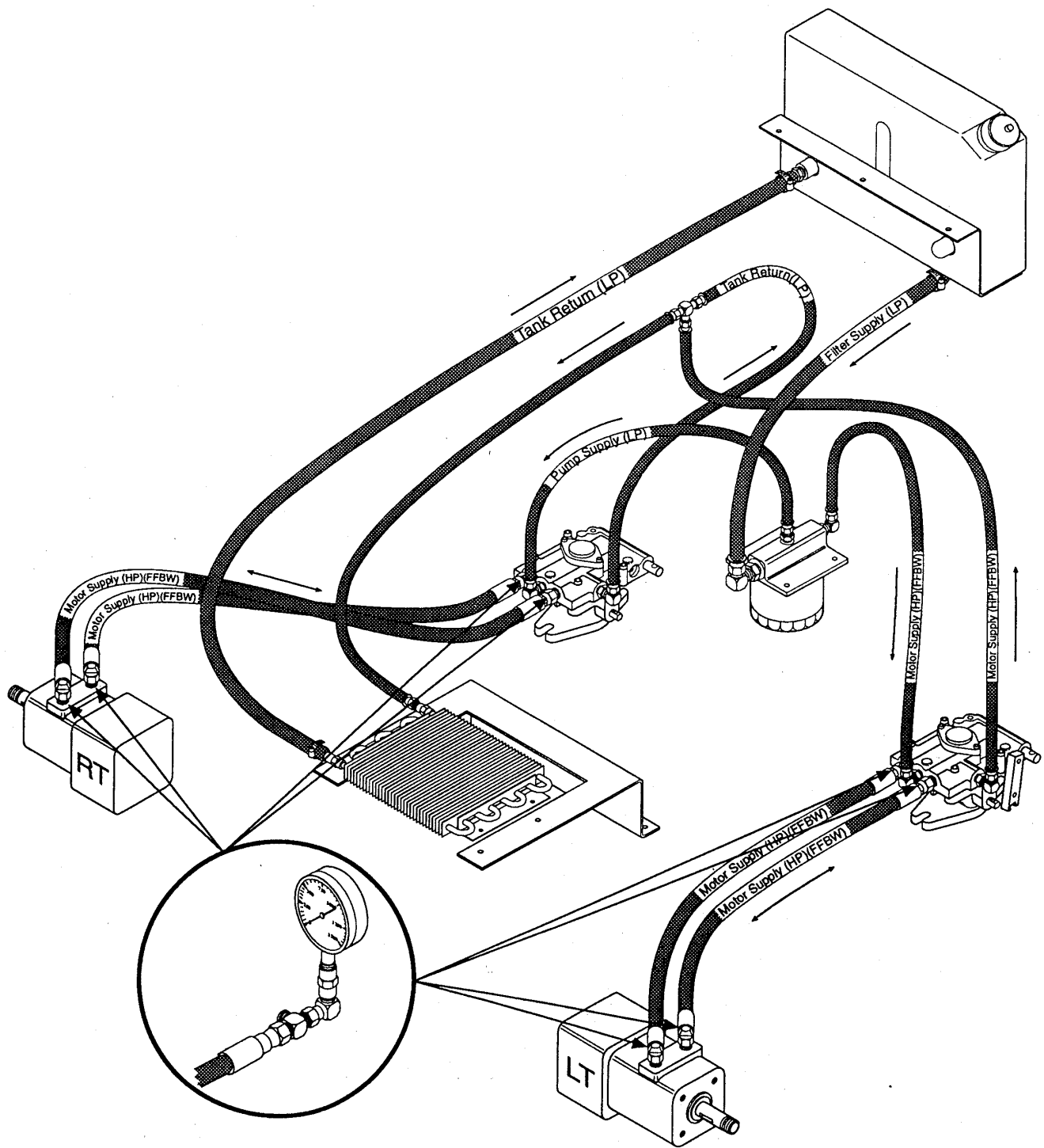
7. Reverse disassembly procedure to reassemble.
8. Refer to *Hydraulic Servicing and Run-In Procedure*.

9.6 HYDRAULIC COOLER REMOVAL AND INSTALLATION

1. Loosen the clamp on the forward hydraulic hose with an open-top container handy. Pull the hose from the fitting and let drain. Some oil will run from the cooler.

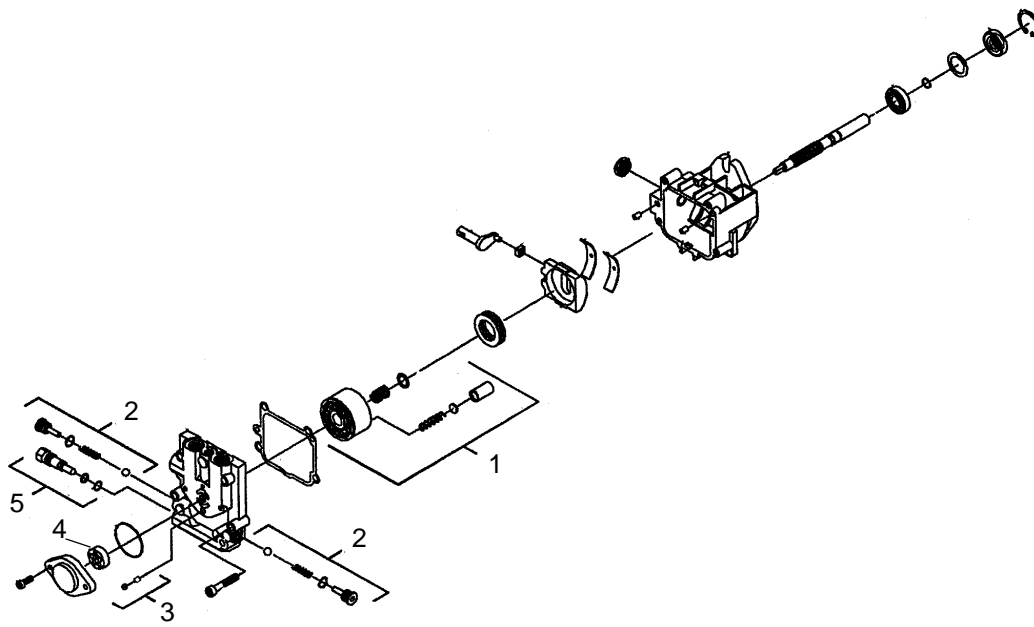
NOTE: If the hose is lowered it will deplete the right side of the hydraulic tank.

2. Loosen the rear hydraulic hose by using an 11/16" wrench along with a 5/8" wrench on the oil cooler fitting to prevent damage from twisting the cooler fitting off. Drain oil from line into container.
3. Remove the four bolts and lock nuts to remove the cooler from the bracket.
4. Remove the cooler bracket by removing the two bolts and lock nuts located between the bracket and fuel tank.
5. Inspect and replace any worn or damaged parts.
6. Reverse the disassembly procedure to reassemble.
7. Refer to *Filter Change and Run-In Procedure*.



LP = Low Pressure
 HP=High Pressure
 FFBW=Fluid Both Ways

Figure 13



- | | |
|----------------------------|---------------------|
| 1. Cylinder Block Kit | 4. Gerotor Assembly |
| 2. Check Valve Kit | 5. Bypass Valve Kit |
| 3. Charge Relief Valve Kit | |

Figure 14

9.7 HYDRAULIC PUMP REMOVAL

Left or Right Side

1. Loosen the tension on the hydro pump drive belt. Remove belt from pump pulleys.
2. Remove the 10 mm bolt and washer on the bottom of the pump shaft (on the pulley). Loosen the two 7/16" bolts on the pulley. Slide the pulley off and remove key.
3. Remove neutral adjustment weldment and speed control arm. Removal of detent strap is not needed.
4. Remove the two 1/2" nuts and bolts that hold the flanged support bushing. Slide the bushing out.
5. Remove the pump control bracket.
6. If right pump is to be removed disconnect PTO safety switch to prevent damage to wires.
7. Pinch off filter to pump hose and cooler to pump hose at pump. Be sure not to over-pinch and damage hoses. Remove hoses. Hold over container and drain hoses. Cap off hoses to prevent contamination.
8. Remove two hoses to the motor and cap off.
9. Remove the two 9/16" nut and bolts holding the pump and lift the pump out.

10. Inspect and replace any worn or damaged parts as needed.

9.8 OVERHAUL SEAL KIT INSTRUCTIONS

Use seal kit P/N 588003 to overhaul pump.

The procedure below is for the disassembly and replacement of the BDP-10L variable pump end cap gasket, O-rings, and shaft seal.

Cleanliness is a primary means of assuring satisfactory hydraulic unit life on either new or repaired units. Cleaning parts by using a clean solvent wash and air drying is usually adequate. As with any precision equipment, all parts must be kept free of foreign materials and chemicals. Protect all exposed sealing surfaces and open cavities from damage and foreign material.

During assembly of the pump all surfaces which have relative motion between two parts must be coated with a film of clean oil or a lubricant such as petroleum jelly. This will assure that these surfaces will be lubricated during start-up.

All gasket sealing surfaces must be cleaned prior to installing new gaskets.

Charge Pump

The charge pump rotation is determined by the orientation of the charge pump cover on the end cap.

1. Make note of the correct orientation prior to removing the charge pump cover. Marking the cover and end cap is the easiest way to insure proper orientation.
2. Using a 5 mm hex wrench, remove the two screws holding the charge pump cover to the end cap.
3. Remove the charge pump cover and O-ring. Remove the charge pump gerotor assembly. Then remove the charge relief valve spring and ball.
4. Inspect the gerotor assembly, charge pump cover, and end cap for abnormal wear, damage or foreign material.

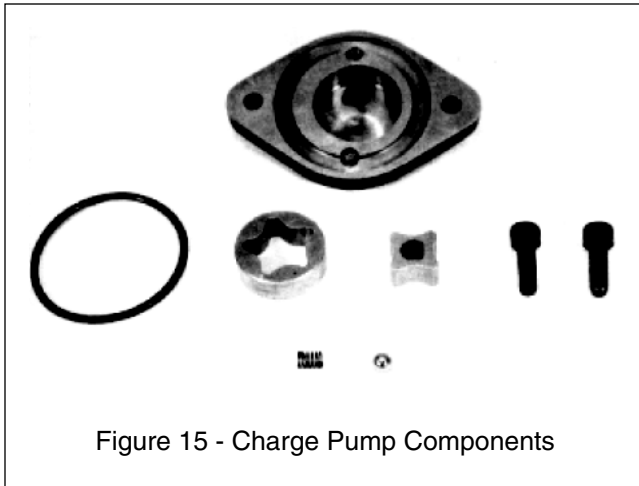


Figure 15 - Charge Pump Components

Disassembly Procedures for the End Cap

1. Using a 6 mm hex wrench, remove the 4 screws which retain the end cap to the pump housing. The internal springs should separate the end cap from the housing. Remove the end cap from the housing.

CAUTION: The pump cylinder block will stick to the surface of the end cap. A small screwdriver between the block and end cap will aid in separation. Exercise caution to prevent damage to the end cap and cylinder block sealing surfaces.

2. Remove the old gasket from the housing.

CAUTION: Do not damage the running surfaces of the cylinder block.

3. Install a new end cap gasket onto the housing.
4. Lubricate the running surfaces of the end cap and cylinder block. Position the end cap with the

housing dowel pins, and install the end cap onto the housing.

CAUTION: Be certain all parts are properly aligned. Do not force the end cap into position on the housing. Caution must be exercised to prevent damage to the end cap and cylinder block seating surfaces.

5. When the end cap is properly installed, the internal springs will hold it away from the housing approximately 3/8" (10 mm).
6. Install the 4 screws which retain the end cap to the variable pump housing. Torque the screws evenly to 138-180 in-lbs (16-20 Nm).

Prior to installing the charge pump, apply a small quantity of petroleum jelly to the ID, OD and side faces of the gerotor assembly.

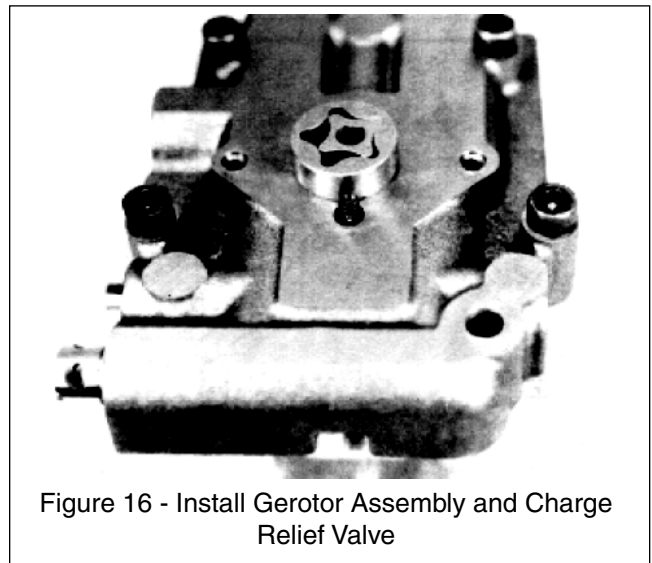


Figure 16 - Install Gerotor Assembly and Charge Relief Valve

7. Install the charge relief valve ball and spring. The charge relief ball goes into the end cap charge hole pocket first and the spring is installed between the ball and recess of the charge cover.
8. Install the charge pump gerotor assembly.
9. Install the charge pump cover and O-ring. The charge relief valve spring must enter the recess in the cover.
10. Install the charge pump cover screws. Torque the 5 mm screw to 84-100 in-lbs (9.8-13.5 Nm).
11. Rotate the shaft to assure correct assembly. When properly assembled, minimal torque should be required to turn the shaft.

9.9 O-RINGS

To replace an O-ring on a check valve plug, remove the plug and with a small screwdriver or hook, stretch the O-ring off the plug. Apply clean petroleum jelly to the new O-ring and roll it into its groove. While installing the plug, use care to align the plug stem with the proper

proper core to avoid damage. Torque plug to 15-35 ft-lbs (20-47 Nm).

To replace an O-ring and a back-up ring on the bypass valve, remove the valve, and with a small screwdriver or hook, stretch the O-ring off the valve. The back-up ring is split and may be removed in the same manner. Apply petroleum jelly to the new back-up ring and the new O-ring. Install the new back-up ring prior to installing the new O-ring. Torque bypass valve to 7-10 ft-lbs (9.4-13.5 Nm).

9.10 SHAFT SEALS

Lip-type seals are used on the input shaft, and displacement control shaft of the Series 70 pumps. These seals can be replaced without major disassembly of the unit. However, replacement of the seals generally requires removal of the pump from the machine.

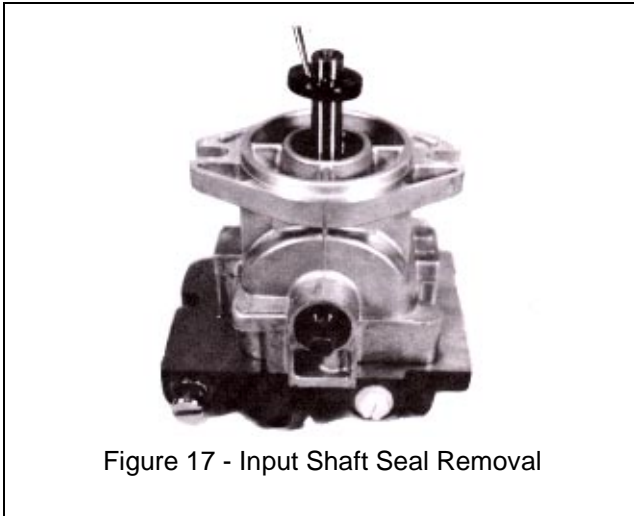


Figure 17 - Input Shaft Seal Removal

1. To replace the pump input shaft seal, first remove the retaining ring from the housing.
2. Carefully pull the seal out of the housing bore. A hook-type tool may be used to grasp the seal and pull it out. A slide hammer-type puller may also be used to remove the seal. Care must be taken so as not to damage the housing bore, shaft sealing surface, or bearing. Once removed the seal is not reusable.
3. Inspect the sealing area on the shaft for rust, wear, or contamination. Polish the sealing area on the shaft if necessary. Lubricate the new seal with petroleum jelly.
4. Wrap the spline or key end of the shaft with thin plastic to prevent damage to the seal lip during installation. Slide the seal over the shaft and press it into the housing bore. Be careful not to damage the seal.
5. Install the seal retaining ring in the housing.
6. The displacement control shaft seals may be replaced by following a similar procedure. These

seals are not held in position by a retaining ring. Press in flush to bottom of bore.

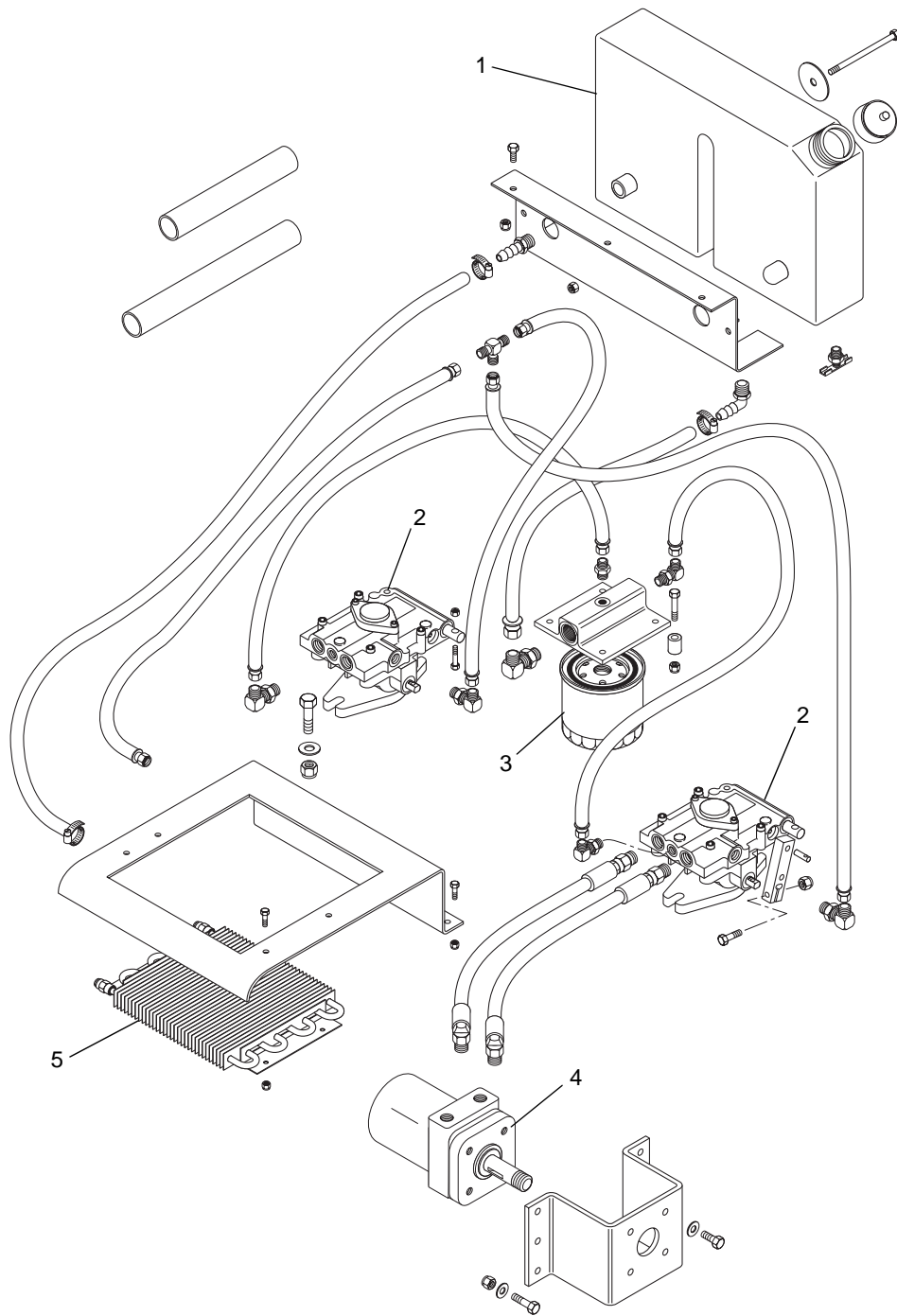
7. Reverse the disassembly procedure to reassemble.
8. Check that there is no binding of speed control linkage when assembled.
9. Adjust the drive belt tension by turning the two nuts on the idler rod until the correct air cap of approximately 0.010 inches (0.25 mm) is obtained. Lock the two jam nuts together.
10. Grease the flanged support bushing.
11. Refer to *Filter Change and Run-In Procedure*.

9.11 HYDRAULIC MOTOR REMOVAL & REPLACEMENT

1. Refer to *Wheel and Hub Removal*.
2. Place an open-top container under the motor and clean the two hose fittings prior to removing the hydraulic hoses.
3. Disconnect the two hydraulic hoses, cap hoses, and motor inlet parts to prevent contamination.
4. Loosen the four bolts holding the hydraulic motor. Be sure to support the hydraulic motor when removing the bolts to prevent it from falling out and causing damage.

NOTE: There is no rebuild kit available for the hydraulic motor. Replacement of the motor is necessary if it is damaged.

5. Inspect and replace any worn or damaged parts.
6. Reverse the disassembly procedure to reassemble.
7. Refer to *Wheel and Hub Installation*.
8. Refer to *Filter Change and Run-In Procedure* sections.



- 1. Hydraulic Tank
- 2. Variable Pump
- 3. Filter Element

- 4. Hydraulic Wheel Motor
- 5. Oil Cooler

Figure 18

PG0291

SECTION 10 - ELECTRICAL

10.1 TOOLS

There are some specialized tools and test equipment that are needed for electrical repair work. A brief description of these follows.

Long or needle nose pliers - used to connect or bend wires and connectors in close quarters.

Diagonal cutters - used to cut wires or trim connections.

Wire stripper/crimping tool - available separately or as a combination tool. Used to strip insulation from wires of various sizes, crimp terminals and connector or wires.

Soldering gun or soldering iron - used to solder all splices and connections to terminals, connector, etc. A soldering gun is faster and more convenient than waiting for a soldering iron to heat.

Multimeter - analog or digital, to measure voltage, amperage and ohms.

Tachometer - used to measure engine speed.

Required to properly test alternator and charging circuits where output is dependent upon engine speed.

Heat gun - used to shrink insulated tubing in place. Used to replace electrical tape or insulated sleeving. To use, place a piece of shrink tubing over a wire joint, heat with the heat gun, until it shrinks slightly around the joint.

Supplies - electrical tape, rosin core solder (never use acid or acid core solder on electrical joints), an assortment of various size terminals, connectors, insulated or heat shrink tubing (for use on joints and connections), and an assortment of automotive type wire (in several colors).

Gravely Company recommends that all work be done in a professional manner. The use of the tubing to cover joints and the soldering of connections contribute to a professional looking job. In addition to a pleasing appearance, repairs made in this manner are more likely to withstand vibration. (The weakest points in an electrical system are the joints where wires are attached.)

Replace all defective components with Gravely replacement parts only. Engine parts, such as rectifiers or alternator components should be secured through the nearest engine service center.

Gravely Company does not recommend attempting to repair electrical components. Most do not lend themselves to repair and you would have more money invested in "time of repair" than the part would cost and the results may not be as good.

10.2 ELECTRICAL MEASUREMENTS

In many electrical circuits, there is some visible effect which indicates that the circuit is functioning properly. A

switch is turned "ON" and a lamp lights. A key is turned, a starter motor runs and cranks the engine. If the lamp does not light, or the starter motor does not run, some means of measuring voltage, current flow, resistance and continuity is needed, (continuity means there is a complete electrical path through the circuit or component.)

To know exactly what conditions exist in an electrical circuit requires AC and DC Voltmeter, AC and DC Ammeter, and an Ohmmeter.

Multimeter

A single combination meter that does all of these things is available. Such a meter is called a Multimeter or Volt-Ohm-multitester (VOM). Meters of this kind are available in many forms and all change functions and ranges with switches, or by plugging test leads into different jacks. Multimeters are available in two basic types, Analog and Digital.

Analog Meters

Analog Meters have a needle that moves across a scale to give a reading. The longer the scale, the easier it is to read and more accurate the reading will be. A jeweled movement is used in this type of meter is more likely to be damaged through rough handling (except for overloaded Protected Meters) or by measuring high values that exceed the range set on the meter than a digital meter. They provide excellent service for the money as long as they are used with care.

Digital Meters

Digital Meters do not have a movement and are therefore more rugged. The reading shows up directly on a display window of some type. Since they read direct, no skill in reading the scale is required, nor is it necessary to set the range. The meter switches the ranges automatically. One has only to select the function DC Volts, AC Ampere, Ohms, etc., connect the test leads, and the reading is shown on the display. Because of the internal circuitry and the lack of a movement, these meters are not likely to be damaged by overloads. In the discussions that follow, either type of meter may be used. Test procedures are the same. It is best to learn proper procedures, even though some meters may be more forgiving of mistakes. Where differences in use may occur, they will be covered in the discussion.

Voltage Measurement

There are two basic rules to be remembered when using a voltmeter. A voltmeter measures the voltage difference between the test leads and the voltmeter is always connected across the circuit under test.

Current Measurement

The two rules to remember when measuring current with an ammeter are; an ammeter measures the current that flows through the meter, and to measure current an ammeter must be connected into the circuit. The latter rule means that the circuit must be opened, and the ammeter wired into it. Because this procedure is usually difficult, an ammeter is seldom used for troubleshooting.

Resistance Measurement

An ohmmeter is used to make resistance measurements and to check continuity through wires and electrical components.

There is one rule to keep in mind when using an ohmmeter. The ohmmeter has a self contained battery and requires no electrical power. Using the ohmmeter on a circuit that has power applied may result in damage to the meter.

IMPORTANT: Disconnect the equipment battery when making Ohmmeter test or damage to the Ohmmeter may result.

IMPORTANT: An ohmmeter reads the resistance of whatever component is connected between the test leads. It can be used to check wires, coils, light bulbs, or any item that conducts current.

10.3 BATTERY

When charging battery, remove it from unit first. Keep batteries out of reach of children. ALWAYS follow information provided on battery by battery manufacturer. Lead acid batteries generate explosive gases. Severe chemical burns can result from improper handling of battery electrolyte. Wear safety glasses and proper protective gear when handling batteries to prevent electrolyte from coming in contact with eyes, skin or clothing.



WARNING: ELECTRIC SHOCK may result in injury and/or damage to unit.

DO NOT allow tools or other objects to come into contact with both terminal at the same time. ALWAYS remove Negative (-) Cable first to reduce risk of sparks when removing battery. ALWAYS connect Positive (+) Cable first, then connect Negative (-) Cable when installing battery.



WARNING: EXPLOSIVE GASES can result in serious injury or death. ALWAYS keep open flames, sparks, or smoking materials away from battery.

POISONOUS BATTERY FLUID contains sulfuric acid and its contact with skin, eyes or clothing can cause severe chemical burns. ALWAYS wear safety glasses and protective gear near battery.

DO NOT TIP any battery beyond 45 degree angle in any direction.

ALWAYS KEEP BATTERIES OUT OF REACH of children.



WARNING: REVERSE CONNECTIONS may result in sparks which may result in injury. ALWAYS connect/disconnect cables in proper order.

Set-Up

The new battery is dry charged. The dealer or customer must add electrolyte (sulfuric acid and water).

1. Remove the battery from the unit.
2. Remove all the vent caps from the battery and set the caps to one side.
3. Take the electrolyte which should be 1.265 specific gravity at 80°F, and fill each cell so that the electrolyte is level with the bottom of the fill ring.
4. The battery should stand for 1/2 hour. Now check electrolyte level in each cell again. If necessary add more electrolyte to bring the level up to the bottom of the ring.
5. Charge until all cells are gassing freely, and the specific gravity is constant over three successive readings taken at 30 minute intervals.
6. Immediately after charging check level of electrolyte. If the level is low add distilled water to bring it up to the required level.
7. Replace the vent caps. It is not necessary to tighten more than finger tight.
8. Wash off the battery to remove electrolyte which may have spilled.

Battery Electrolyte First Aid

External contact: Flush with water.

Eyes: Flush with water for at least 15 minutes and get medical attention immediately!

Internal contact: Drink large quantities of water. Follow with Milk of Magnesia, beaten egg or vegetable oil. Get medical attention immediately!

IMPORTANT: In case of internal contact, DO NOT induce vomiting!

Clean Battery

Corrosion and dirt on the battery and terminals can cause the battery to "leak" power.

- Remove battery. (See *Battery Removal and Installation*)
- Rinse the battery with plain water and dry.
- Clean terminals and battery cable ends with wire brush until bright.
- Coat terminals with grease or petroleum jelly.
- Reinstall battery.

Inspection, Cleaning, Drying, and Maintenance

Inspect the top of battery, terminals, cables, terminal posts, and case for any accumulation of dirt, corrosion cracks or loose or broken parts. Keep battery and its terminals clean. Inspect monthly to maintain best performance. Replace battery if damaged.

Remove hold down and bolt and lift battery out. Clean or service battery away from unit. Remove corrosion from battery terminals and cable connections with wire brush, then wash with a weak baking soda solution.

Scrub the exterior of the battery and cable terminals with a nonmetallic brush which has been dipped into a mixture of baking soda and water.

After cleaning, apply a thin coat of grease or petroleum jelly to terminals and cable ends to retard corrosion. Reinstall battery.

Check the alternator voltage regulator output (if used) at every periodic maintenance inspection. Over charging is a common cause of battery failure.

Electrolyte Level

Every 25 hours of operation, check electrolyte level of each cell by removing caps one at a time. The electrolyte level should be at level indicated. Use distilled water to fill each cell if needed. Install and tighten each cap after checking.

IMPORTANT: When distilled water is added to battery during freezing weather, battery must be charged to mix water with electrolyte, or water will remain at top and freeze.

Charging

ALWAYS follow information provided on battery by battery manufacturer. Contact battery manufacturer for extensive instructions to charge battery.

Place unit on a level surface, shut off engine and open battery compartment to gain access to battery.

Disconnect negative (-) cable first, then positive (+) cable.

To charge battery:

1. Loosen strap and remove battery from unit.
2. Place battery on bench or other well ventilated place where electrolyte spill will not create damage.

3. Remove caps and fill each cell to level indicated with electrolyte at 1.230 specific gravity and 80°F (27°C).
4. Let battery stand for one half hour.
5. Check electrolyte level and add more if necessary.
6. Connect positive (+) lead of charger to positive (+) terminal, and negative (-) lead to negative (-) terminal.
7. Charge the battery at two and a half amps for ten hours or until all cells are gassing freely and the specific gravity is constant over three 30 minute intervals.

Specific Gravity Check

The specific gravity should be checked with a hydrometer.

NOTE: The specific gravity should be checked in each cell and should be the same for all cells. A variation in a cell reading could be an indication of a problem. Subtract .004 from 1.265 for each 10°F below 80°F (27°C) or add .004 to 1.265 for each 10°F above 80°F (27°C).

A special temperature compensated hydrometer is used to read the battery's state of charge.

The reading on the hydrometer gauge should be above 1.225. If the reading falls below 1.225 specific gravity there will be an insufficient charge.

ALWAYS charge the battery until the specific gravity of 1.265 is reached over 3 successive readings. Check monthly to ensure charge is maintained. The approximate state of charge can be determined by the cell specific gravity of the rested open circuit voltage at room temperature and the charging time can be estimated. For example:

OCV	Specific Gravity	% of Charge	Charging Time
12.60	1.265	100%	---
12.4	1.225	75%	3 hours
12.20	1.180	50%	7 hours
12.00	1.130	25%	10 hours
11.80	1.100	0%	12 hours

If using an automatic tapering 12 volt charger, choosing a good quality 5 to 10 amps 15VDC minimum output charger and charge for 3 to 12 hours according to the battery state of charge (see table above) or until the specific gravity in each cell reaches 1.255 - 1.265 specific gravity at 80°F (27°C).

If using a constant current charger, charge at 1 to 2 amperes for the time given on the table above or until full specific gravity is reached.

IMPORTANT: Charging at higher rates will damage the battery and cause excessive gassing and acid spewing.

Battery Charger

Under normal conditions the engine alternator will keep the battery charged. When unit has set for an extended period of time without operation and the battery has been completely discharged, a battery charger will be required for recharging.

Before using a charger, an attempt can be made to recharge the battery using the engine alternator by jump starting the unit and allowing the engine to run.

Jump Starting

Jump starting, battery charging, or replacement is required when the starter motor will not crank the engine.

The unit used for jump starting should have a 12 volt battery with at least 500 cold cranking amperes, and a negatively grounded system.



WARNING: FROZEN BATTERIES CAN EXPLODE and result in death or serious injury. DO NOT charge a frozen battery. Let the battery thaw out before putting on a charger.
UNIT MOVEMENT can result in death or serious injury. NEVER jump start unit directly to the starter or starter solenoid. Unit can move forward or backward and injure the person jump starting unit.

To jump start the battery:

1. Ensure battery is not frozen. If the fluid is frozen, remove battery from unit and allow to thaw before charging.
2. Connect the positive (+) jumper cable to the positive (+) terminal of the discharged battery.
3. Connect the other end of the same jumper cable to the positive (+) terminal of the booster battery.
4. Connect one end of the second jumper cable to the negative (-) terminal of the booster battery.
5. Make the final jumper cable connection to the engine block or the furthest ground point away from the discharged battery.



WARNING: Make sure cables are clear of any moving engine parts before starting engine.

6. Start engine (refer to Owner's Manual). If engine will not start after several tries, unit or battery may need service.
7. After engine starts, leave cables connected for one to two minutes.
8. Disconnect cables in reverse order.

9. Operate unit as normal to charge battery.

Storage

The battery is a perishable item and it should be stored properly to obtain a long, useful life. Batteries not in use will self discharge.

If the battery will not be used for more than three months, it should be removed and stored in a cool, dry place.

Any collection of dirt, grease, or electrolyte should be removed from the top of the battery.

The battery must be recharged monthly or when the cell specific gravity reads less than 1.255 specific gravity. Before reinstalling the battery in the spring, it should always be fully recharged.

10.4 SWITCHES

Switches either open a circuit to stop current flow or close and allow current to flow through.

A normally open (N.O.) switch prevents current flow until the switch is actuated, completing the circuit and allowing current to flow through it. An example is a light switch - the lights are off until the switch is actuated and the lights go on.

A normally closed (N.C.) switch allows current to flow until the switch is actuated, breaking the circuit and stopping current flow through it. An example is an ignition switch that grounds the magneto when in the off position (completing the circuit) but opens the circuit when in the ON position allowing the engine to operate.

Switches are selected with regard to Current rating (contacts must be of sufficient size to carry the required current), Voltage rating (switches insulated for specific voltages), Case or housing (switches that are exposed to moisture and must be sealed to prevent moisture from entering), and Actuating type (push, pull, rotary, momentary contact, or micro switches).

NOTE: Check that the connections to the switches are secure and that a switch is being activated properly before performing electrical test on switches. (Safety switches on speed selector and clutch levers may be out of adjustment and not activating.)

IMPORTANT: When checking switches, remove them from their respective circuit by disconnecting the wires from the switch at the connector(s). Damage could result to the meter or machine components if switches are left in.

Normally Open Switch

To test a normally open switch (key, headlight, safety, or seat) connect the ohmmeter across the switch terminals. Meter should indicate open circuit (infinite resistance). Activate the switch. The ohmmeter should read up scale to zero resistance (Close Circuit). This indicates the switch is operating properly. Also check from each terminal to the switch case (if case is metal).

reading should show infinite resistance indicating no short to ground.

Variation from test results described indicates a defective switch.

Normally Closed Switch

To test a normally closed switch connect the ohmmeter across the switch terminals. Meter should indicate a closed circuit (zero resistance). Activate the switch and the meter should move to open circuit (infinite resistance). Check from each terminal to ground (switch case). Meter should show open circuit (infinite resistance).

Variation from test results described indicates a defective switch.

Ignition Switch

NOTE: Refer to the wiring diagram of the unit involved to determine switch functions and test using the methods described.

The ignition switch incorporates a number of functions, although not all functions are used on all equipment. The switch has three positions: OFF, RUN, and a momentary contact START position. Use an ohmmeter to check the continuity of the switch in each position.

OFF Position - Should be continuity between contacts G and M. These connections ground the engine magneto and stop the engine in the OFF position.

RUN Position - Should be continuity between contacts B and A. These connections supply power to the rest of the wiring harness. Connections G and M open to each other.

START Position - Hold switch in START position while testing. There should be continuity between contacts S1 and S2. These connections apply power to close the solenoid contacts and operate the starter motor.

In addition to the above test, place the switch in the run position and check between each contact and ground (metal case) to be sure no terminals are grounded. If the switch is operating properly, there will be no continuity between contacts other than those described.

10.5 SOLENOID AND RELAYS

Solenoid and relays are both magnetically operated devices. Both devices operate on the principle that passing a current of electricity through a coil of wire will create a magnetic field strong enough to attract a piece of iron or steel. Each device uses this principle in a slightly different manner.

Relay - A basic relay consists of a coil of wire wound around a soft iron (magnetic) core. When current is passed through the coil, the core is magnetized and pulls down on a magnetic lever. The lever in turn is attached to several switch contacts which open or close other electrical circuits. In this fashion, a small current can control one or more larger electrical currents and actuate several other devices. In most

cases a relay contact moves only a fraction of an inch and the magnetic pull is small.

Solenoid - A basic solenoid consists of a coil of wire wound around a hollow tube. A magnetic core slides inside the tube. When current is passed through the coil, the core is pulled into the solenoid with considerable force. With proper design, a solenoid can exert considerable force over a distance of several inches. A solenoid can therefore, pull a lever, close a heavy contact, or perform other jobs that require a straight line pull.

If a relay or solenoid fails to operate, the cause may be either electrical or mechanical.

To check electrically, connect a voltmeter across the coil of the device and activate the circuit that operates the relay or solenoid. If the meter indicates no voltage is applied, the cause is in the control circuit.

If the meter indicates proper voltage across the coil but the device does not function, remove the power, disconnect the wiring and check the continuity of the coil with an ohmmeter. The meter should indicate resistance, in the order of 3 to 5 ohms, if the coil is intact. A high resistance indicates an open coil and a defective device.

There are also a number of mechanical problems that may cause the problem.

The starter solenoid in the Gravely equipment is a sealed unit used to actuate the starter motor on the engines. These solenoids may have three or four connections. The two large connections carry high current to operate the starter motor. The small connections are connected to the coil and carry the control current.

To check the solenoid, disconnect the cables to the starter motor, turn the ignition switch to the start position, and listen for the solenoid to snap inside contacts closed.

If no snap is heard, check across the coils with a voltmeter. The voltage should read 12 volts with the ignition switch in the start position. If no voltage appears, the defect is in the start circuit.

If the voltage is correct, turn off the power and check continuity of the coil with an ohmmeter. If the coil is open, the solenoid is defective and must be replaced.

If the coil has the proper voltage applied, and the continuity check indicates the coil is intact, the solenoid plunger is stuck or the contacts are welded shut and the solenoid must be replaced.

If the solenoid snaps shut, but the start does not operate, check across the large contacts with an ohmmeter. If there is no continuity when the solenoid snaps shut, the contacts are defective and the solenoid must be replaced.

10.6 LIGHTING CIRCUITS

Lighting circuits are simple circuits and easiest to trouble shoot in most equipment. They consist of the lights connected in parallel; a normally open switch, a protective fuse and a source of power (battery or engine alternator).

If only one light is out, check the connector, then check the bulb for continuity (high resistance indicates a defective or burned out bulb).

If all the lights are out, check the fuse for continuity (high resistance indicates a defective or blown fuse). If the fuse is blown, check for a short in the wiring and correct before replacing the fuse.

If the fuse and lamps are good, check the circuit with an AC/DC voltmeter.

10.7 FUSES

Fuses are connected in electrical circuits to protect the circuits from damage due to overload or short circuits. Fuses are a "weak link" in the circuit. They contain a metal link designed to melt when a certain current value is exceeded thus opening or disconnecting the wiring. Once a fuse blows or melts it must be discarded and replaced with a new fuse of the same value.

Since the function of the fuse is to protect the circuit, NEVER attempt to defect the protective device by bridging or replacing with a device of a higher current rating.

Electrical testing of these devices is simple. Since the device either conducts current (and is therefore functioning) or the device is open and is therefore defective. Use an ohmmeter to check for continuity.

10.8 DIODES AND RECTIFIERS

Diodes are solid state, semiconductor devices. They contain no moving parts and conduct current better in one direction than the other.

Diodes allow current to flow through one circuit without "backing up" into another. In engine alternator circuits, a diode is used to convert current which flows back and forth (AC) in a circuit to current which flows only in one direction (DC). A device which converts alternating current to a direct current is called a RECTIFIER. A diode is one type of rectifier.

To check a diode, isolate it from the circuit by disconnecting one end. With a multimeter set on the lowest ohms scale setting, measure the resistance in one direction, reverse the test leads, and measure in the other direction. Readings should be high in one direction and low in the other. (If the readings are low in both directions, the diode is shorted, and if the readings are high, the diode is open.) If the readings are the same in both directions, the diode is defective and must be replaced.

IMPORTANT: Diodes are marked to indicate polarity (a band on one end, an arrow on the side, or they fit on a holder only one way).

Rectifiers

A battery is charged through the use of an alternator located in or on the engine. A charging circuit contains a rectifier because alternators produce alternating current (AC) and batteries require direct current (DC) for charging.

The rectifier may be built into the engine or it may be an external part. It may also contain a regulator to prevent overcharging the battery. (Servicing of rectifiers built into the engine should be done by an approved engine manufacturer's service center. Such a service center has access to the information and parts required to test and repair or replace engine components, including rectifiers and regulators.)

Units that contain both a rectifier and regulator are tested in a working circuit to make sure the regulator portion of the device is operating.

10.9 ELECTRIC CLUTCH

The electric clutch is used to turn on and off the attachment used on the unit by use of a switch. The clutch is also designed so that a brake is applied to the output shaft when the clutch is disengaged (off).

The field coil is mounted to a bearing support and does not rotate. The rotor is attached to the power output shaft and rotates around the field assembly. The armature is attached to the output pulley. The armature assembly is held close to the rotor by the brake assembly. The clutch is engaged by applying current to the coil connection. This results in a current flowing through the coil, magnetizing the coil pulling the armature onto the rotor with sufficient force to hold the two pieces together, effectively connecting the output and the input shafts together. Pulling the armature against the rotor pulls it away from the brake, releasing the brake.

Engine Electrical Components

Engine servicing and repair should be referred to local engine manufacturers service centers that have the service information and parts available to properly service the engine. Gravelly dealers should be able to test engines and engine components to pinpoint troubles and narrow them down to properly advise the engine serviceman.

10.10 CHECKING THE PTO CLUTCH

Measure Clutch Coil Resistance

1. Turn engine and PTO switch off.
2. Disconnect clutch wire connections.
3. Select meter to check ohms.

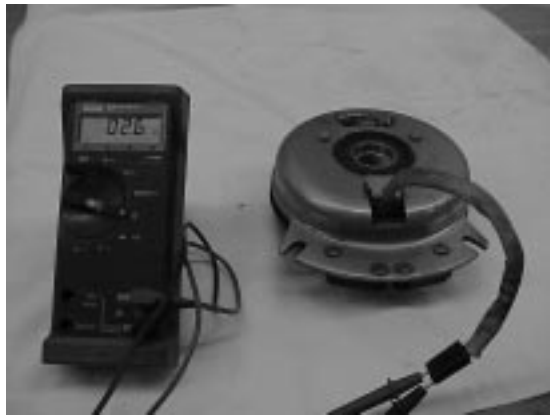


Figure 19

4. Connect meter leads wires in clutch connector.
5. If meter reads below 2.50 ohms or above 3.50 ohms, then the clutch has failed and needs to be replaced.
6. If meter reads between 2.50 to 3.50 ohms, proceed to Measure Clutch Current Draw.

Measure Clutch Current Draw

1. Turn engine off.
2. Disconnect clutch wire connections. Remove 30 amp fuse.
3. Select meter to check amps (10 amp scale).
4. Place meter leads into fuse holder.
5. Sit on the seat to make seat switch connections.
6. Turn the ignition switch to RUN and the PTO switch to ON.
7. If the meter reads below 4.5 amps, the problem is in the electrical system leading to the clutch (Battery, relay, switch wiring).

If you find after measuring clutch coil resistance and clutch current draw that:

1. The resistance falls between 2.50 and 3.50 ohms.
2. The amp draw is 4.50 or above.
3. The electric clutch is within factory specifications and is not the source of the problem.

10.11 PRO300 ELECTRICAL

Initial check out: If power is not available to start the engine use the following steps:

STEP 1

Check out the battery. Using a hydrometer on all the battery cells to see if one or more is bad. Also use a voltmeter to check for proper voltage. Replace the battery if necessary and/or charge to proper level.

STEP 2

Use a voltmeter to make sure you have battery voltage to terminal (B) on the back side of the ignition switch in the off position. If you don't have battery voltage to terminal (B) check the battery connection and the fuse in the red lead.

STEP 3

With the ignition switch in the "run" position, check to see if power is being transferred from terminal (B) to terminal (A). Terminal (A) on the ignition switch supplies battery voltage to the back of the PTO switch on the purple lead. Terminal (A) also supplies battery voltage to terminal 30 on PTO relay and to the hour meter. When the operator has operator presence bale (O.P.B.) depressed, battery voltage will transfer from terminal 30 to terminal 87 and on to the front terminal #4 of the PTO switch.

STEP 4

With ignition switch in the start position, battery voltage is transferred from terminal S2 to S1. Terminal S1 (brown wire) transfers battery voltage to the starter solenoid relay (86). Check voltage from starter solenoid relay 87 (brown/white wire) to starter solenoid engine.

PTO clutch check out: Remove the wiring harness PTO clutch leads from the clutch. With a multimeter check the clutch coil for resistance to see if the coil is good (3.0-3.9). If the resistance is 0 or higher the coil is bad.

Ignition switch check out: Battery voltage check in the "off" position, check for voltage at terminal "B". It should not be present on terminals A, S1, S2.

With the ignition switch in the "run" position, check for battery voltage at terminal B, A, S2. It should not be present at terminal S1.

With the ignition switch in the "start" position, check for battery voltage at terminals B, A, S2, S1.

PTO switch check out: The PTO switch is a push/pull switch with normal open and closed contacts. Power transfer should be checked with a voltmeter. The switch contacts should be checked with an ohm meter with the wire harness plug removed. The light switch is similar to the PTO switch with only one set of contacts.

Diode check out: Diodes are checked with an ohm meter set on the diode check, and should only pass voltage in one direction. If it passes voltage in both directions or not at all the diode needs to be replaced.

Check Points for DC Voltage Readings

Key Switch	Off	Run	Start
B	11.50-13.00	11.50-13.00	11.50-13.00
A		11.50-13.00	11.50-13.00
S-1			11.50-13.00
S-2		11.50-13.00	11.50-13.00

Contact resistance is 0.1-0.3 ohms when correct.

PTO Switch	Off	Run	Start
Yellow/Red (2)		11.50-13.00	11.50-13.00
Purple/white (2)	Connected to PTO Clutch		
Purple		11.50-13.00	11.50-13.00
Brown/Yellow		11.50-13.00	11.50-13.00

2 sets of contacts, one normally open, one normally closed. Contact resistance is 0.1-0.3 ohms when correct.

Normally open contacts (big terminals) coil resistance 3.0-5.0 ohms. Contact resistance is 0.1-0.3 ohms when correct. Electrically activated.

PTO Clutch	Off	Run	Start
Purple/white			
Black	Connected To Ground		

Coil Resistance check clutch specifications.

10.12 INTERLOCK SWITCH

1. Remove the subject interlock switch from the unit.
2. Set a VOM switch in the ohm (Rx1) position.
3. Connect the meter leads to the switch pins
4. No circuit (infinity) should be indicated.
5. Push in on the interlock switch plunger. A circuit (zero ohms) should be indicated.
6. Connect one lead to the case and sequentially through the switch pins with the other lead. No circuit (infinity) should be indicated.
7. Replace the switch if it fails the above test.

10.13 FUSE HOLDER

1. Use a VOM with the switch set in the ohm (Rx1) position.
2. Make a visual check of the fuse to determine that it is not burned out. If the glass is clouded, check with an ohmmeter (zero ohms).
3. Unplug the fuse holder and connect the ohmmeter to the pins. A circuit (zero ohms) reading should be indicated.
4. If no circuit is indicated, replace the fuse holder.

10.14 CONTINUITY DIAGRAMS

Models 988089, 310

The diagrams below show the various states of connection for electrical components.
The solid lines on switches show continuity.

NOTE: All switches are viewed from the rear.

<p>Key Switch (03602300)</p> <p>OFF RUN START</p>	<p>Relay (03042800)</p> <p>NOT ENERGIZED ENERGIZED</p>
<p>Bale and Neutral Switch (09251900)</p> <p>BUTTON IN BUTTON OUT</p>	<p>PTO Switch (00522100)</p> <p>DISENGAGED (down position) ENGAGED (up position)</p>

Models 988090

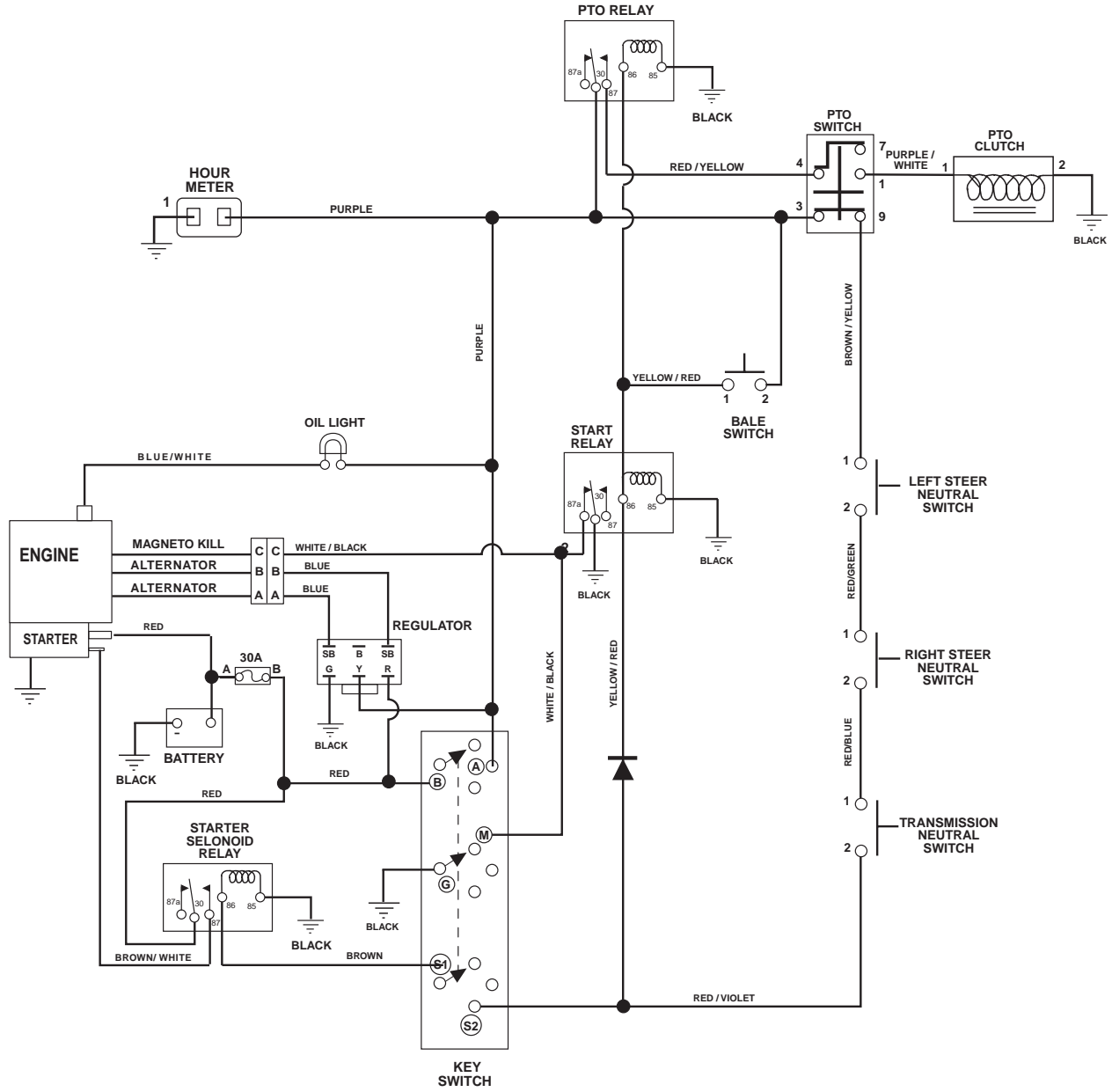
The diagrams below show the various states of connection for electrical components.
The solid lines on switches show continuity.

NOTE: All switches are viewed from the rear.

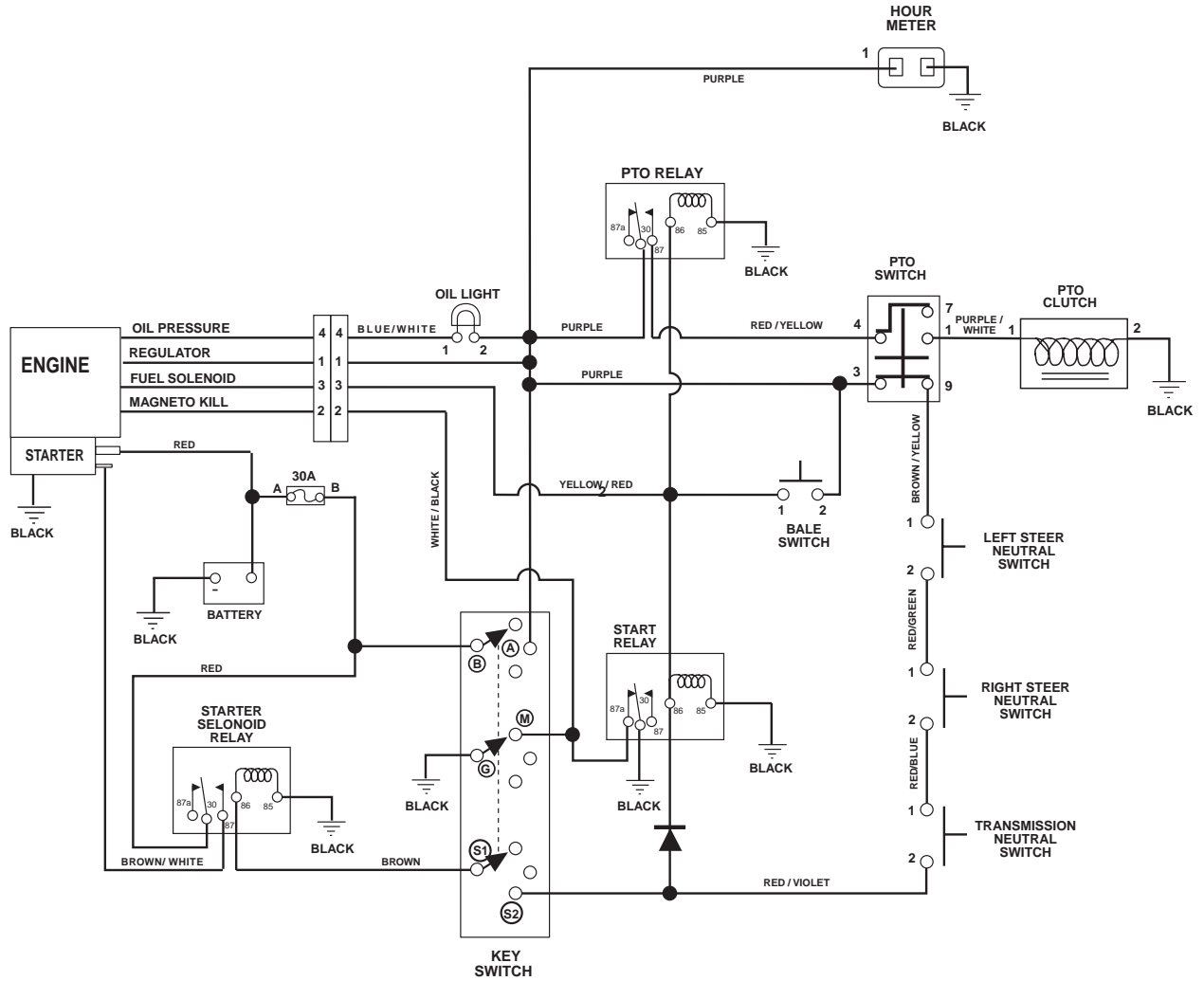
<p>Key Switch (03602300)</p> <p>OFF RUN START</p>	<p>Relay (03042800)</p> <p>NOT ENERGIZED ENERGIZED</p>
<p>Bale and Neutral Switch (09251900)</p> <p>BUTTON IN BUTTON OUT</p>	<p>PTO Switch (01545600)</p> <p>DISENGAGED (down position) ENGAGED (up position)</p>

10.15 WIRING DIAGRAM

Models 988089, 310



Models 988090



PG0373



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