MM146

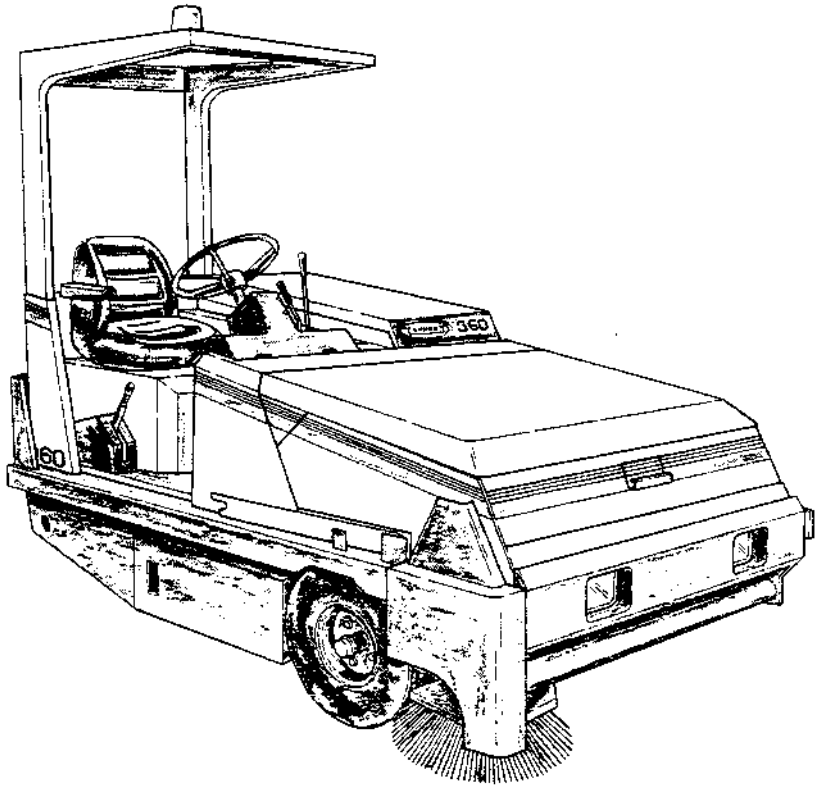
10-85

360

POWER SWEEPER

Operation, Maintenance, and Parts Manual

Operator Manual



SPECIALIZED MAINTENANCE EQUIPMENT

SWEEPERS • SCRUBBERS • SCARIFIERS • FLOOR COATINGS

Home | Find... | Go To.. | ◀ | ▶

360
POWER SWEEPER

This manual is furnished with each new TENNANT® Model 360. The machine operators will easily learn how to operate the machine and understand its mechanical functions by following the directions and absorbing the information in the Operation section.

This machine will give excellent service and sweeping results, and save maintenance expenses. However, as with all specially engineered mechanical equipment, best results are obtained at minimum costs if:

- The machine is operated with reasonable care and
- The machine is maintained regularly -- per the maintenance instructions provided.
- Components used in this machine have been carefully selected for performance and safety. Use only Tennant Company supplied or equivalent parts.

Parts and supplies may be ordered by phone or mail from any Tennant Company parts and service center, distributor, or from any of the Tennant Company subsidiaries.

The telephone number, telex number, mailing addresses, and locations are listed on the last page of the manual.

MANUAL NO. MM146
Published: 10-85

SAFETY PRECAUTIONS

The following symbols are used throughout this manual as indicated in their descriptions:

DANGER: To warn of immediate hazards which will result in severe personal injury or death.

WARNING: To warn of hazards or unsafe practices which could result in severe personal injury or death.

CAUTION: To warn of hazards or unsafe practices which could result in minor personal injury.

ATTENTION! To warn of unsafe practices which could result in extensive equipment damage.

NOTE: To give important information or to warn of unsafe practices which could result in equipment damage.

The following information signals potentially dangerous conditions to the operator or equipment. Read this manual carefully. Know when these conditions can exist. Locate all safety devices on the machine. Then take necessary steps to train machine operating personnel how to use those safety devices. Report machine damage or faulty operation immediately to personnel responsible for the repair of the machine. Do not use the machine if it is not in proper operating condition.

WARNING: Do not operate the machine until you have read and understood the operating instructions and are properly trained. Failure to do so could result in severe personal injury.

WARNING: Before operating the machine, make sure all safety devices are in place and operate properly. Check the foot and parking brakes and the steering control for proper operation. Do not start machine unless you are in operator's seat, with foot on the brake pedal or operational parking brake engaged and the directional pedal in the "neutral" position. Failure to do so could allow machine to move immediately upon start-up, resulting in severe personal injury.

WARNING: If an LPG fuel leak is found, close the service valve immediately and notify the appropriate personnel to avoid fire or explosion.

WARNING: Provide adequate ventilation when operating machine to prevent buildup of engine exhaust gases. Improper or inadequate ventilation will cause asphyxiation. Check exhaust system regularly for leaks.

WARNING: Do not operate machine in flammable or explosive environment. Machine is not designed for such an environment. It could cause ignition of flammable or explosive materials.

WARNING: Do not operate machine in areas with possible falling objects unless machine is equipped with overhead guard.

WARNING: Dirt, dust, and projectiles may be generated by the machine when in operation. Safety glasses or goggles must be worn by the machine operator to protect eyes. Failure to do so could cause serious eye injury.

WARNING: Excessive noise may be generated by the machine when it is operated for extended periods of time in certain confined or noisy areas or in certain conditions of disrepair, as set by the Occupational Safety and Health Act, maximum 85 db at the operator's ear. Hearing protection should be worn under such conditions to avoid hearing loss.

WARNING: Do not carry riders on machine. Machine is designed to carry one operator; riders could fall off and become seriously injured.

WARNING: Always follow safety and traffic rules of the area in which the machine is being operated to prevent serious injury.

WARNING: Use care when backing machine to prevent injury to bystanders.

WARNING: Do not drive the machine for any great distance or at high speed with the hopper raised. A raised hopper reduces machine stability.

WARNING: Be sure adequate vertical clearance is available before attempting to high dump the hopper. Failure to do so could cause overhead objects to fall or could cause electrical shock if overhead wiring is contacted.

WARNING: Do not fill the fuel tank while the engine is operating. Always be sure the fuel container and the machine are electrically connected before pouring fuel. This can be done by using a battery clip and insulated wire, permanently attached to the fuel container. Clip the wire to the machine before pouring. Failure to electrically connect the fuel container to the machine may allow a static electricity spark to ignite the fuel, resulting in a fire or explosion.

WARNING: Do not operate the machine on grades steeper than 15° with an empty hopper, and 10° with a full hopper, the maximum rated ramp angles. Operating the machine on steeper grades may cause the machine to become unstable. Use service brakes to control and slow machine speed.

WARNING: Machine should not creep when the directional control pedal is in the "neutral" position. Adjust control pedal linkage to stop machine creeping.

WARNING: Always engage the hopper safety bar before working under a raised hopper. Do not rely on the machine hydraulic system to keep the hopper in the "raised" position. The hydraulic system may leak internally, allowing the hopper to lower, crushing anything under it.

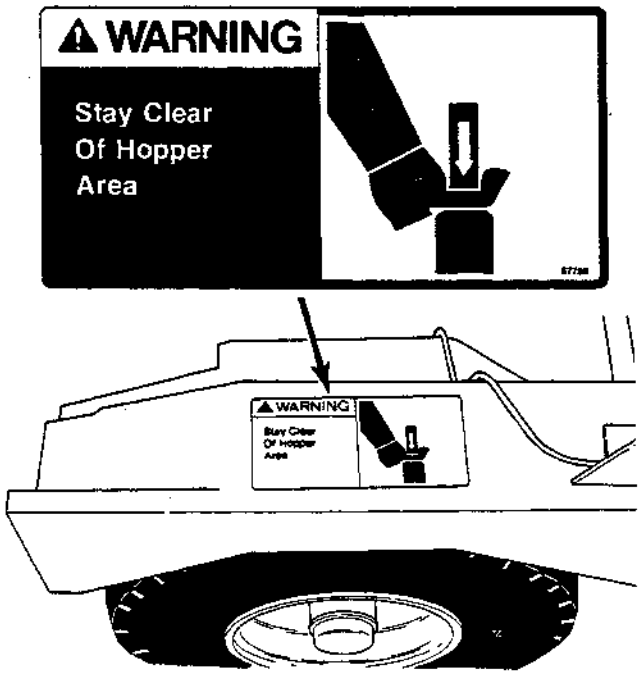
WARNING: Always park on a level surface, stop the engine, and engage the parking brake before making adjustments. Always wear approved eye protection when working on machine.

WARNING: Avoid moving parts of the unit. Loose jackets, shirts, or sleeves should not be permitted when working on machine because of the danger of becoming caught in moving parts. Keep shields and guards in position. If adjustments must be made while the unit is running, use extreme caution around hot manifolds, moving parts, belts, etc.

WARNING: Always stop the machine on a level surface, stop the engine and engage the parking brake before working on the machine to keep it from rolling.

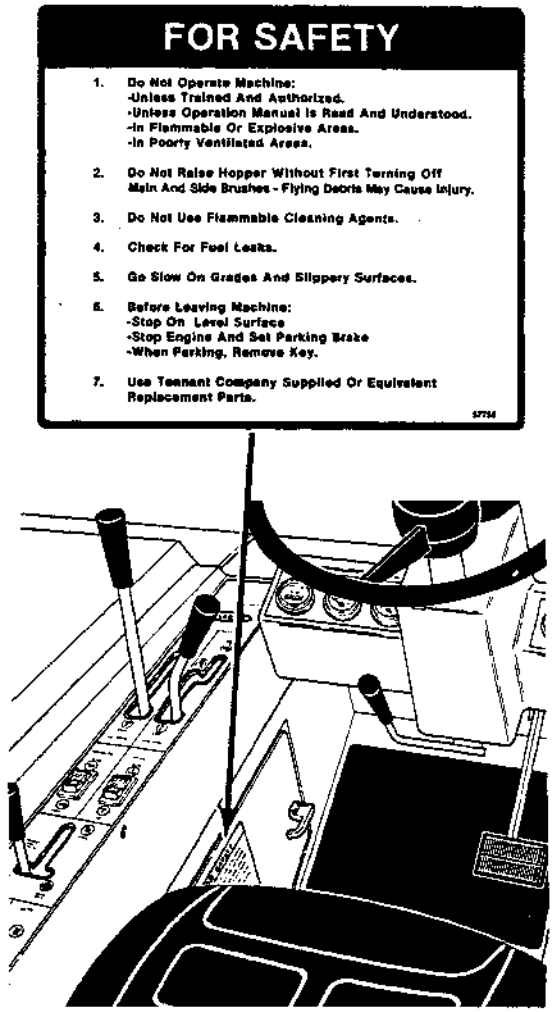
WARNING: No smoking or open flame should be allowed when the fuel system is being repaired or serviced. The area should be properly ventilated. Improper handling of fuel or fuel fumes could result in an explosion or fire.

The following safety decals are mounted on the machine in the locations indicated. If these, or any, decals become damaged or illegible, install a new decal in its place.



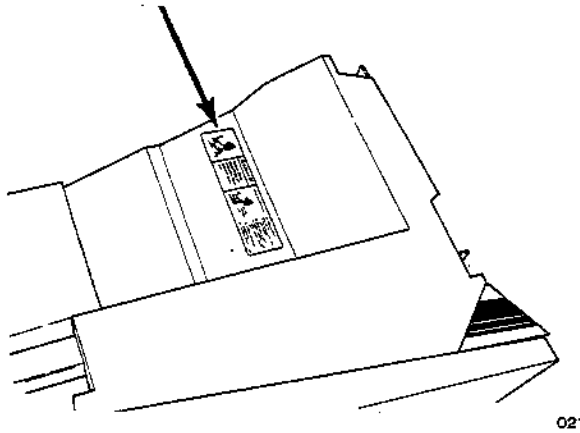
02141

HOPPER CLEARANCE DECAL - LOCATED ABOVE EACH FRONT WHEEL



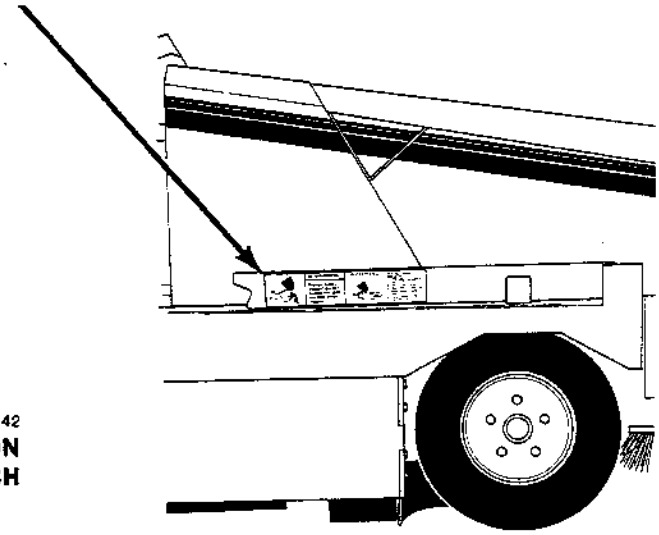
02139

SAFETY DECAL - LOCATED ON LEFT SIDE OF OPERATOR COMPARTMENT.

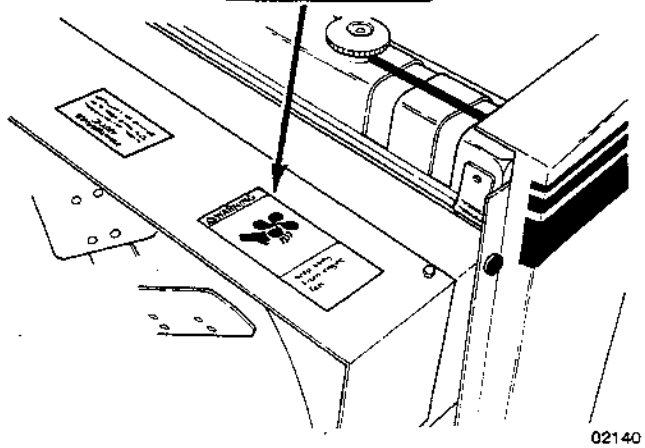


02142

SAFETY SUPPORT BAR DECAL - LOCATED ON HOPPER SAFETY SUPPORT BAR AND ON EACH SIDE OF THE HOPPER



02143



02140

ENGINE FAN DECAL - LOCATED ON RADIATOR SHROUD

GENERAL INFORMATION

CONTENTS

CONTENTS

SECTION 1
SPECIFICATIONS

CONTENTS

MACHINE SPECIFICATIONS

POWER TYPE

Engine type - piston
Ignition - breaker-type spark
Cycle - 4
Aspiration - natural
Cylinders - 4
Bore - 3.19 in (81 mm)
Stroke - 3.06 in (78 mm)
Displacement - 98 cu in (1600 cc)
Net power - 35 hp (26 kw) @ 2400 rpm governed
47.5 hp (35 kw) @ 3600 rpm maximum
Fuel - gasoline, 91 RON octane minimum, unleaded or LPG
Cooling system - water/ethylene glycol antifreeze
Electrical system - 12 V nominal, 37 A alternator

POWER TRAIN

Propelling - hydraulic drive motor, rear wheel
Main brush - hydraulic drive motor
Rotary Seal™ - hydraulic drive motor
Side brush - hydraulic drive motor
Vacuum fan - belt driven

STEERING

Type - rear wheel controlled, hydraulic cylinder and rotary valve
Power source - hydraulic accessory pump
Emergency steering - manual

HYDRAULIC SYSTEM

Function - operates propelling, hopper lift, steering, main brush drive, Rotary Seal™ drive, side brush drive

Control valve, main brush, Rotary Seal™, side brush, lift cylinders - open center, single spool, solenoid operated.

Control valve, steering - open center type, rotary, non-load reacting

Pump, propelling - variable displacement piston type, 1.24 cu in (20 cc) maximum displacement per revolution, 11.4 gpm (43 L/min) @ 2400 rpm

Propelling system relief pressure - 4000 psi (27,850 kPa)

Pump, accessories - gear type, 0.84 cu in (14 cc) displacement, 10.3 gpm (39 L/min) @ 2400 rpm

Side brush and Rotary Seal™ system relief pressure - 1800 psi (12,410 kPa)

Steering system relief pressure - 500 psi (3450 kPa)

Main brush and lifting cylinders system relief pressure - 2000 psi (13,790 kPa)

Motor, propelling - internal gear type, 19 cu in (310 cc) displacement per revolution, 4500 psi (31,028 kPa) maximum rated pressure

Motor, main brush - internal gear type, 3 cu in (50 cc) displacement per revolution, 2500 psi (17,238 kPa) maximum rated pressure

Motor, Rotary Seal™ - internal gear type, 0.79 cu in (13 cc) displacement per revolution, 2500 psi (17,238 kPa) maximum rated pressure

Motor, side brush - internal gear type, 6.2 cu in (100 cc) displacement per revolution, 2500 psi (17,238 kPa) maximum rated pressure

Cylinder, hopper lift - double action type, 2.5 in (65 mm) bore x 12.62 in (320 mm) stroke, 1.25 in (32 mm) diameter rod, 2500 psi (17,238 kPa) maximum rated pressure

Cylinder, steering - double action type, 2 in (50 mm) bore x 8 in (200 mm) stroke, 0.75 in (20 mm) diameter rod, 1500 psi (10,340 kPa) maximum rated pressure

BRAKING SYSTEM

Service brakes - hydraulic drum brakes (2), one per front wheel, master cylinder foot brake actuated.

Parking brakes - utilizes service brakes, cable actuated

SUSPENSION SYSTEM

Front - two 5.70 x 8 pneumatic tires
two 6.00 x 9 solid tires with solid tire accessory

Rear - one 6.90/6.00 x 9 pneumatic tire
one 4.00 x 8 solid tire with solid tire accessory

SYSTEM FLUID CAPACITIES

Engine cooling system - radiator 4 qt (3.8 L)
total system 8.4 qt (8 L)
total system, 9.3 qt (8.8 L) with heater accessory

Engine lubricating oil - 3.5 qt (3.3 L) with filter

Fuel tank - 10 gal (38 L) gasoline
33 lb (15 kg) LPG

Hydraulic system - reservoir 5.3 gal (20 L)
total system 6 gal (23 L)

GENERAL MACHINE DIMENSIONS/CAPACITIES

Length - 97 in (2460 mm)
Width - 58.3 in (1480 mm)
Height - 55 in (1400 mm)
81.6 in (2075 mm) with overhead guard/cab accessory
88.8 in (2255 mm) with overhead guard/cab and rotating/flashing light accessory
Track - 54.5 in (1385 mm)
Wheel base - 54.5 in (1385 mm)
Main brush - overall diameter, 14 in (355 mm)
length, 48 in (1220 mm)
Rotary Seal™ - overall diameter, 6 in (150 mm)
length 47 in (120 mm)
Side brush - diameter, 21 in (535 mm)
Sweeping path width - 48 in (1220 mm)
60 in (1525 mm) with side brush
Hopper capacity - 1200 lb (545 kg)
16 cu ft (0.45 m^3)
Dust filter area - 110 sq ft (10.2 m^2)
220 sq ft (20.4 m^2) with dual air filter accessory

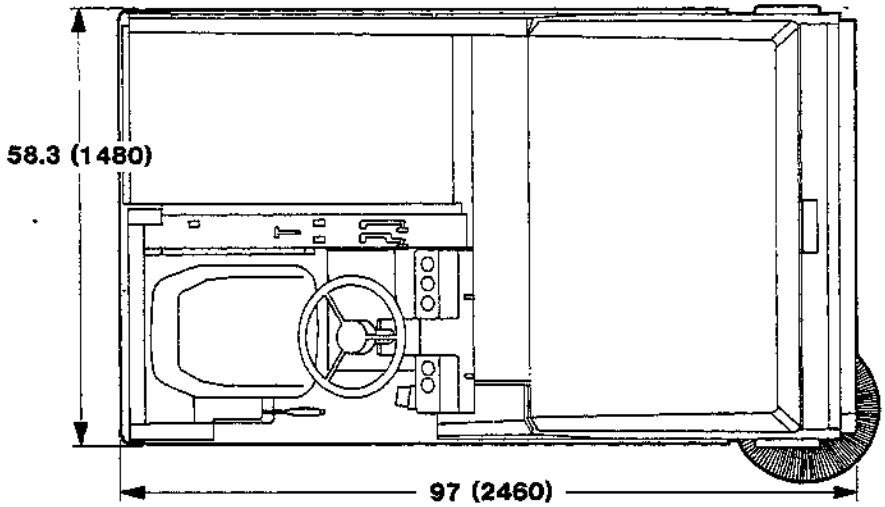
MACHINE WEIGHTS

Net GVWR - 3100 lb (1406 kg)
Net weight, loaded - 4300 lb (1950 kg)

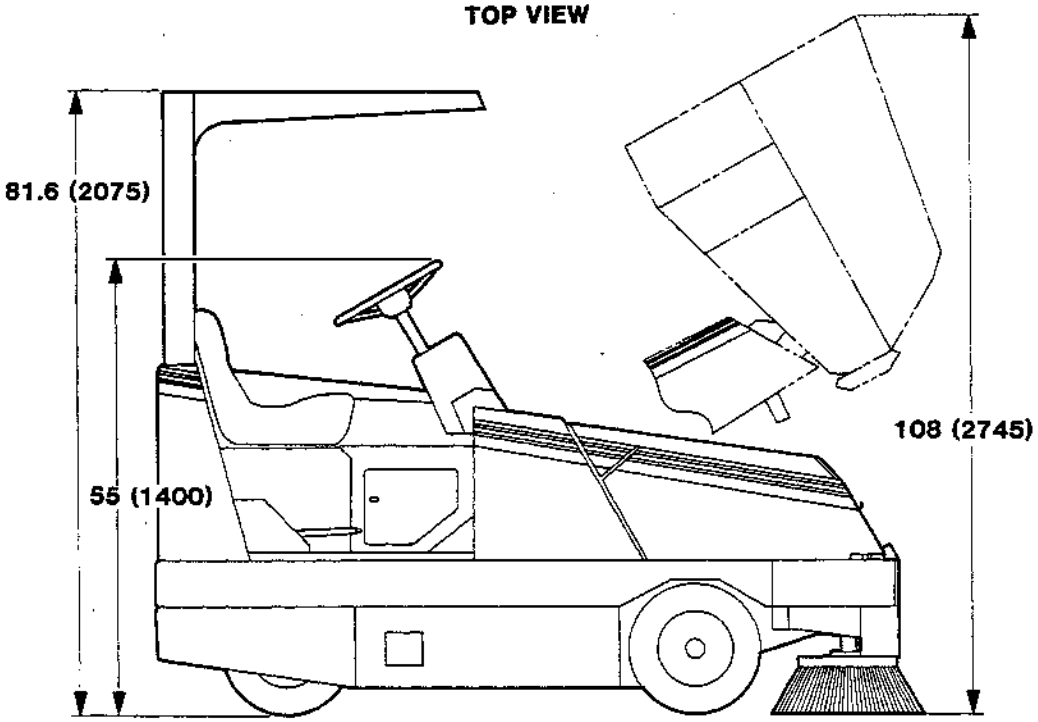
GENERAL MACHINE PERFORMANCE

Maximum forward speed - 8.5 mph (13.7 km/h)
Maximum reverse speed - 3 mph (4.8 km/h)
Turning radius - right, 104 in (2640 mm)
left, 77 in (1955 mm)
U-turn, 118.5 in (3010 mm)

MACHINE DIMENSIONS



TOP VIEW



SIDE VIEW

02146

NOTE: The first dimension is in inches, the second dimension in parenthesis is in millimeters.

POWER SWEEPER - 360 MM146 (1-84) LITHO IN U.S.A.

SECTION 2
OPERATION

CONTENTS

PREPARATION FOR OPERATION

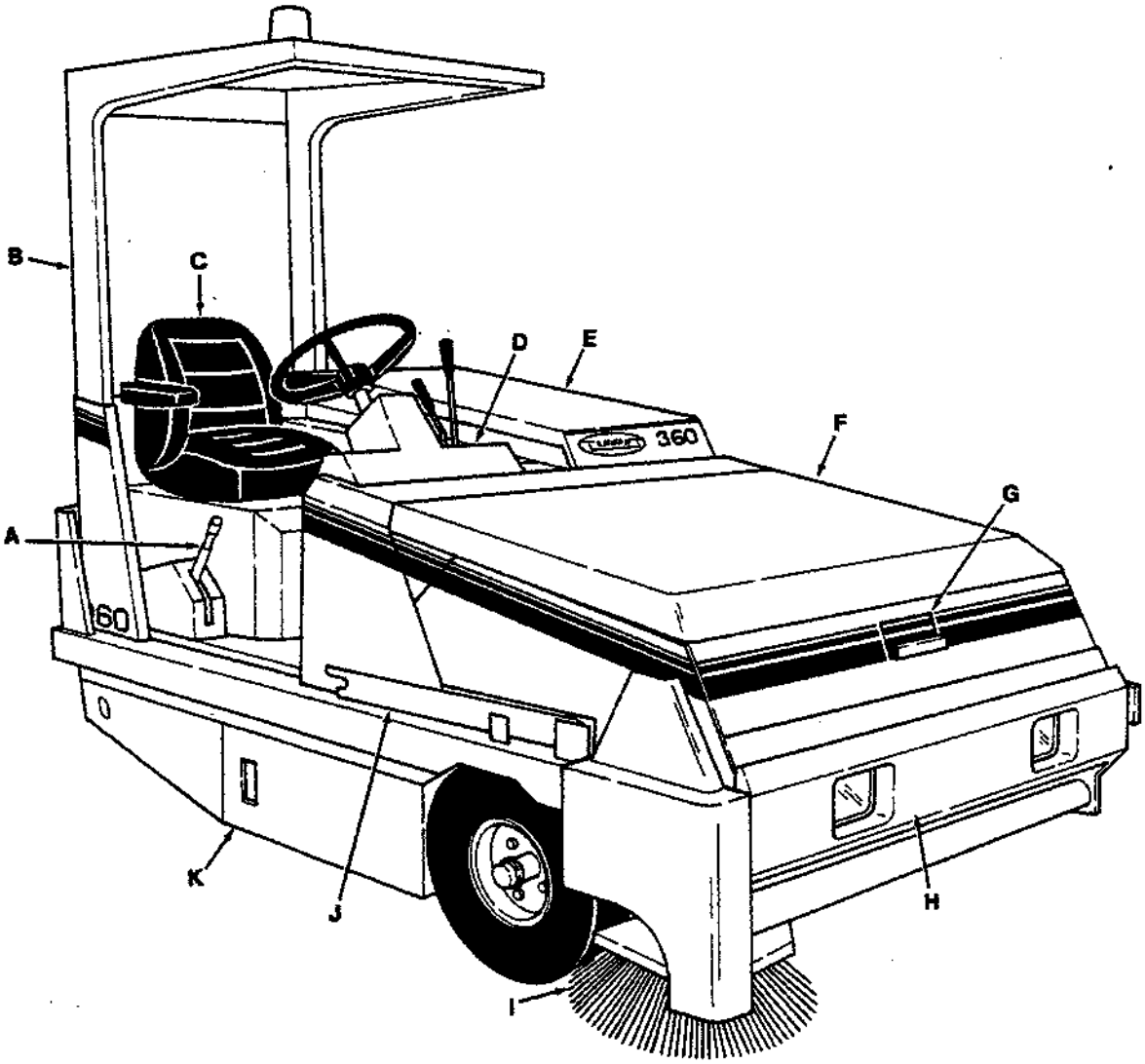
AFTER UNLOADING AND BEFORE OPERATING THE MACHINE:

1. Check the machine for shipping damage.
2. Read this manual carefully before operating or servicing the machine.

WARNING: Do not operate the machine until you have read and understood the operating instructions and are properly trained. Failure to do so could result in severe personal injury.

3. Check the hydraulic fluid level in the hydraulic fluid reservoir, using the dipstick provided. TENNANT® hydraulic fluid is recommended. If TENNANT® hydraulic fluid is not available, use only new, approved hydraulic fluid. See the Hydraulics section.
4. Check the engine oil level.
5. Check the radiator coolant level.
6. Check the brush adjustment, as described in Brushes and Rotary Seal™.
7. Check the air pressure of the tires.
8. Fill the fuel tank, or install an LPG fuel tank on the machine per the instructions in this manual.

WARNING: Do not fill the fuel tank while the engine is operating. Always be sure the fuel container and the machine are electrically connected before pouring fuel. This can be done by using a battery clip and an insulated wire, permanently attached to the fuel container. Clip the wire to the machine before pouring. Failure to electrically connect the fuel container to the machine may allow a static electricity spark to ignite the fuel, resulting in a fire or explosion.

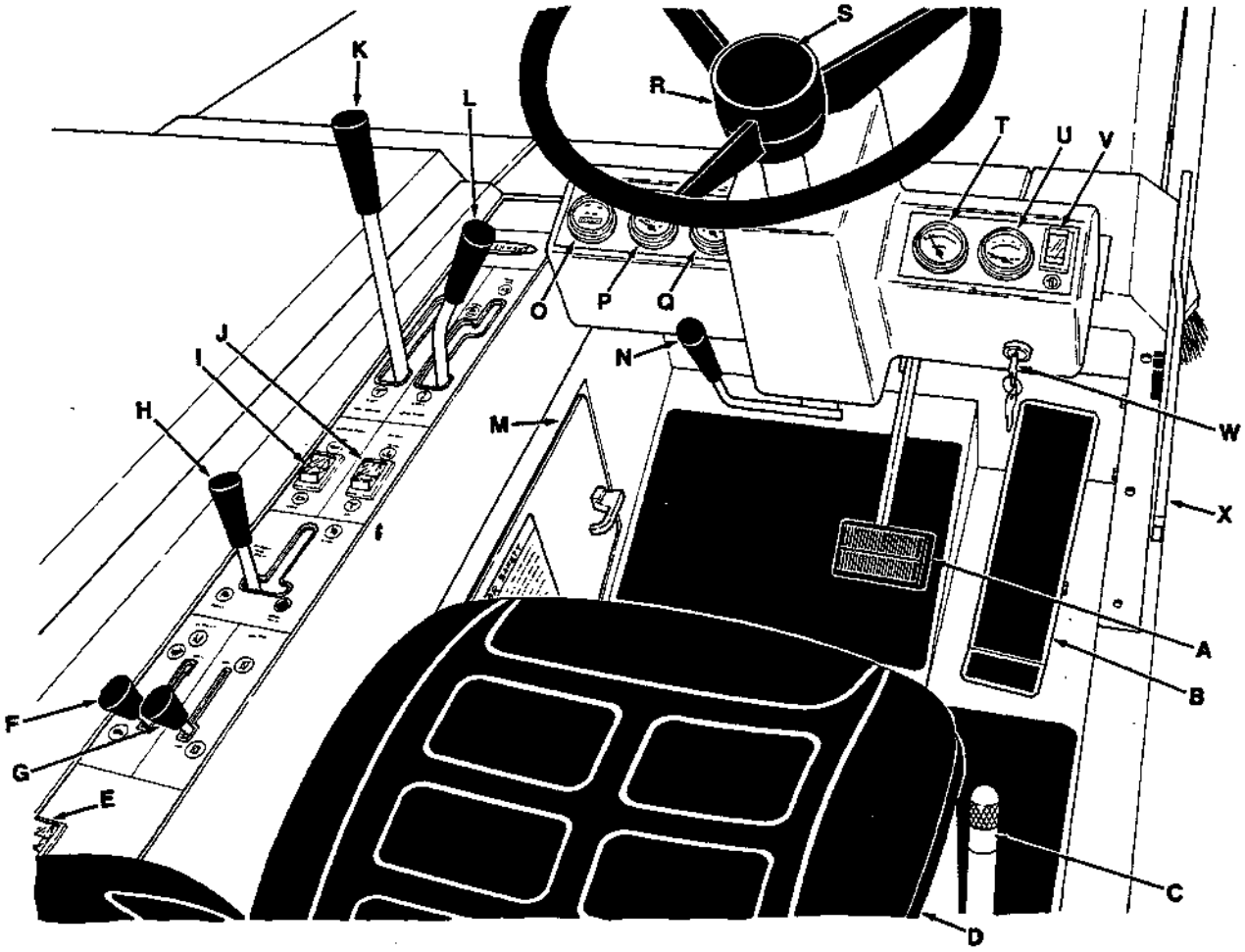


OPERATION OF CONTROLS

02147

MACHINE COMPONENTS

A. Parking Brake
B. Overhead Guard
C. Operator Seat
D. Steering Console
E. Engine Cover
F. Hopper Cover
G. Vacuum Wand Connection Door
H. Hopper Door
I. Side Brush
J. Hopper Safety Support Bar
K. Main Brush Access Door



CONTROLS AND INSTRUMENTS 02148

A. Brake Pedal
B. Directional Control Pedal
C. Parking Brake Lever
D. Operator Seat
E. Hazard Lamp Switch
F. Throttle Control Lever
G. Engine Choke Lever
H. Vacuum Fan Shut-Off Control Lever
I. Hopper Door Control Switch
J. Hopper Position Control Switch
K. Side Brush Control Lever
L. Main Brush Control Lever
M. Main Brush Height Adjustment Knob
N. Steering Console Position Control Lever
O. Engine Hour Meter
P. Engine Oil Pressure Gauge
Q. Engine Coolant Temperature Gauge
R. Steering Wheel
S. Horn Button
T. Fuel Level Gauge
U. Battery Condition Gauge
V. Operating Lamps Switch
W. Ignition Switch
X. Hopper Safety Support Bar

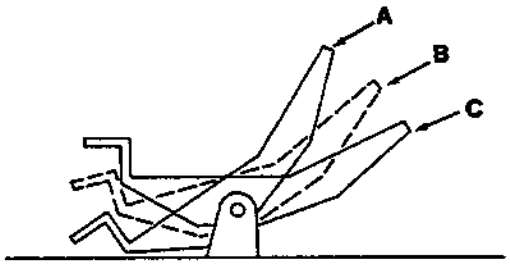
BRAKE PEDAL

The brake pedal operates the hydraulic drum brakes on the two front wheels.

To stop the machine, return the directional control pedal to neutral; then apply pressure to the brake pedal.

DIRECTIONAL CONTROL PEDAL

A single foot pedal controls the hydraulic propelling drive. The foot pedal is used to select the direction of travel and the propelling speed of the machine.



DIRECTIONAL CONTROL PEDAL 00116

A. "Reverse" Position
B. "Neutral" Position
C. "Forward" Position

To travel forward, gradually press the "toe" portion of the pedal; press the "heel" portion of the pedal for reverse travel. The propelling speed of the machine is regulated by varying the pressure on the pedal.

If the machine creeps when the pedal is in the "neutral" position, adjust the pedal as directed in Directional Control Pedal in the Maintenance section.

⚠ WARNING: Always use the brake pedal for normal stopping and controlling machine speed on downgrades to prevent loss of machine control.

PARKING BRAKE LEVER

The parking brake lever controls two brake cables which are connected to the drum brakes on the two front wheels. To engage the parking brake, pull the brake handle up. To disengage the parking brake, push the brake handle down. Always engage the parking brake before leaving the machine unattended and before working on the machine.

⚠ WARNING: Always park on a level surface, stop the engine, and engage the parking brake before leaving the machine unattended and before working on the machine to keep it from rolling.

OPERATOR SEAT

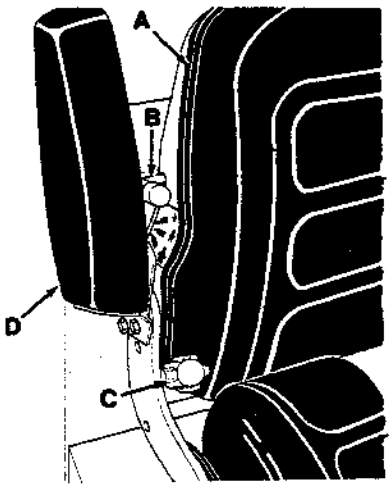
The operator seat is a three-way adjustable seat with armrests. It has adjustments to compensate for operator weight, to vary the backrest angle, and to vary the front-to-rear seat position.

The weight adjustment lever has three positions. One position is for lightweight operators, one for middleweight operators, and one for heavyweight operators. Pull the lever up for lightweight operators, position the lever horizontally for middleweight operators, and down for heavyweight operators.

The backrest angle is adjusted by rotating the knob clockwise to decrease the backrest angle or counterclockwise to increase the backrest angle.

The seat position is adjusted by pulling the seat position lever, located on the lower front edge of the seat, out to the left, sliding the seat forward or backward to a comfortable position, and releasing the lever.

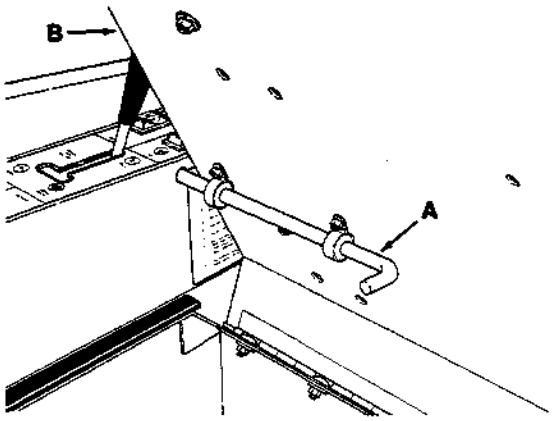
The right side armrest may be rotated up and back to enter or exit from the operator seat.



OPERATOR SEAT 01435

A. Seat
B. Weight Adjustment Lever
C. Backrest Angle Knob
D. Armrest

The operator seat also tilts forward to allow access to the gasoline fuel tank and hydraulic reservoir fill caps. A support rod has also been provided to hold the seat in the "tilted" position.



SEAT SUPPORT ROD 02149

A. Support Rod
B. Seat Base

POWER SWEEPER - 360 MM146 (1-85) LITHO IN U.S.A.

HAZARD LAMP SWITCH

The hazard lamp switch is present on machines with the rotating or flashing lamp accessory. To operate the lamp, press the front half of the switch rocker into the "on" position. To stop lamp operation, press the rear half of the switch rocker into the "off" position.

THROTTLE CONTROL LEVER

The throttle control lever operates a cable which controls the engine governed speed. Pull the lever back to slow the engine to idle speed. Push the lever forward to speed the engine to the maximum governed speed.

ENGINE CHOKE LEVER

The engine choke lever is present on gasoline powered machines. It operates a cable which controls the engine choke. It is not necessary to choke a warm engine. To aid in starting a cold engine, choke it by pushing the engine choke lever forward into the "full" position. After the engine starts and warms up, open the choke by pulling the choke lever back into the "run" position.

VACUUM FAN SHUT-OFF CONTROL LEVER

The vacuum fan shut-off control lever operates a cable which controls the vacuum fan shut-off butterfly. It also controls the hopper dust filter shakers.

To vacuumize the debris hopper, push the control lever forward into the "open" position. To stop the debris hopper vacuum, pull the control lever back and to the left, into the "close" position. To shake the hopper dust filters, pull and hold the control lever back and to the right into the "shake filter" position for ten to fifteen seconds; place the control lever in the "close" position to stop the filter shakers.

HOPPER DOOR CONTROL SWITCH

The hopper door control switch operates an electric actuator which controls the hopper door position. To open the hopper door, press the rear half of the switch rocker down into the "open" position. To close the hopper door, press the front half of the switch rocker down into the "close" position.

HOPPER POSITION CONTROL SWITCH

The hopper position control switch operates an electric solenoid valve and hydraulic lift cylinder which controls the hopper position. To dump the hopper, press the rear half of the switch rocker down into the "up" position. This will place the hopper in the "dump" position. Press the switch rocker until an adequate amount of hopper-to-dumpster clearance is achieved and release the switch. Continuing to press the switch rocker down will raise the hopper to its maximum height.

⚠ WARNING: Be sure adequate vertical clearance is available before attempting to high dump the hopper to avoid falling objects or electrical shock hazard.

To lower the hopper, press the front half of the switch rocker into the "down" position. This will lower and return the hopper to its "operating" position.

SIDE BRUSH CONTROL LEVER

The side brush control lever operates an electric switch and cable. The electric switch operates an electric solenoid valve which controls hydraulic fluid flow to the side brush motor. The cable controls the side brush position.

To lower the side brush and start it rotating, pull the side brush control lever back and to the left; then release the lever into the "down" position.

To raise the side brush and stop its rotation, pull the side brush control lever back to the right and release the lever into the "up-off" position.

NOTE: The side brush will not rotate unless the main brush control lever is in the "normal" or "free-float" positions.

MAIN BRUSH CONTROL LEVER

The main brush control lever operates an electric switch and linkage. The electric switch operates an electric solenoid valve which controls hydraulic fluid flow to the main brush and Rotary Seal™ motors. The linkage controls the main brush position.

To lower the main brush and Rotary Seal™ and start them rotating, pull the main brush control lever back and to the left. Then release the lever into the "normal" position—allowing the lever to move forward and to the right will place the lever in the "free-float" position. The main brush will lower and both the main brush and Rotary Seal™ will start rotating.

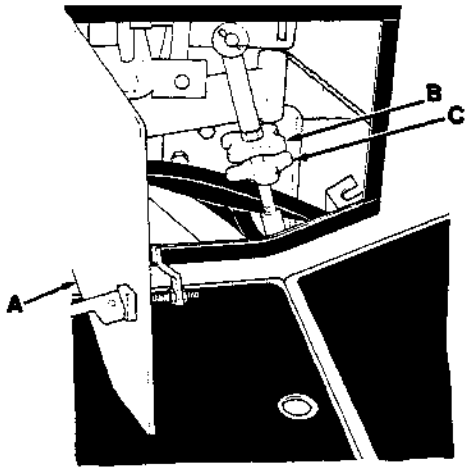
To raise the main brush and stop its rotation, pull the main brush control lever back to the right and release the lever into the "up-off" position.

NOTE: Always place the main brush control lever in the "up-off" position when the machine is idle for a period of time. This will prevent the main brush from getting a flat spot.

MAIN BRUSH HEIGHT ADJUSTMENT KNOB

The main brush height adjustment knob is located behind an access door next to the operator's left foot. It limits the main brush lift linkage travel. The greater the linkage travel, the greater the amount of floor contact the main brush will have.

To raise the main brush and reduce the main brush floor contact, loosen the locking knob and thread the knob clockwise. To lower the main brush and increase main brush floor contact, loosen the locking knob and thread the knob counterclockwise. Retighten the locking knob after making any adjustment.



MAIN BRUSH HEIGHT ADJUSTMENT KNOB 02150

A. Access Door
B. Adjustment Knob
C. Locking Knob

STEERING CONSOLE POSITION CONTROL LEVER

The steering console position control lever controls a catch and ratchet on the base of the steering console.

To adjust the position of the steering console, push the steering console position control lever forward, adjust the console to a comfortable position, and release the lever.

ENGINE HOUR METER

The hour meter records the number of hours the machine has been operated. This information is useful in determining when to service the machine.

ENGINE OIL PRESSURE GAUGE

The engine oil pressure gauge registers the engine oil pressure. Normal engine oil pressure ranges from 20 psi (140 kPa) to 35 psi (240 kPa) at full engine throttle. If the gauge registers an oil pressure reading below 7 psi (50 kPa), stop the engine immediately and determine the cause. Failure to stop the engine will result in engine damage.

ATTENTION! Stop the engine immediately to prevent engine damage if the engine oil pressure gauge registers less than 7 psi (50 kPa).

ENGINE COOLANT TEMPERATURE GAUGE

The engine coolant temperature gauge registers the engine coolant temperature. Normal engine coolant temperatures range up to 263° F (128° C). Temperatures above this level indicate an over-heating engine. This condition may arise due to a low coolant level, a clogged radiator, a loose fan belt, a defective thermostat, or other engine malfunctions. Engine overheating will always cause a coolant loss. If coolant loss does not occur, check for malfunction of the temperature sending unit.

STEERING WHEEL

The automotive-type steering wheel operates a hydraulic control valve which controls a steering cylinder connected to the rear wheel support. It is recommended that the steering wheel not be turned excessively when the engine is not operating. A horn button is located in the center of the steering wheel.

FUEL LEVEL GAUGE

The fuel level gauge is present on all gasoline powered machines. It indicates how much fuel is left in the fuel tank.

BATTERY CONDITION GAUGE

The battery condition gauge indicates the present voltage potential of the battery. Normal battery voltage is 10 to 14 volts. If the battery voltage exceeds 14 volts, it may be overcharging. If the battery voltage falls below 10 volts, it may not be accepting or getting a charge from the alternator. Overcharging and undercharging are indications that one or more electrical components are in need of repair.

OPERATING LAMPS SWITCH

The operating lamps switch controls the head lamps, tail lamps, and side brush spot lamp. To operate the lamps, press the front half of the switch rocker into the "on" position. To stop lamp operation, press the rear half of the switch rocker into the "off" position.

IGNITION SWITCH

The key-operated ignition switch has four positions. These positions are: "accessories," "off," "on," and "start." To start the engine, turn the key fully clockwise to the "start" position. Release the key as soon as the engine starts and the key will place itself in the "on" position. To stop the engine, turn the key to the vertical "off" position.

⚠ WARNING: Before operating the machine, make sure all safety devices are in place and operate properly. Check the foot and parking brakes and the steering control for proper operation. Do not start machine unless you are in operator's seat, with foot on the brake pedal or operational parking brake engaged and the directional control pedal in the "neutral" position. Failure to do so could allow the machine to move immediately upon start-up, resulting in severe personal injury.

NOTE: Do not engage the starter for more than ten seconds at a time, or after the engine has started, as the starter may be damaged.

HOPPER SAFETY SUPPORT BAR

The hopper safety support bar is present on the operator's side of the hopper. It holds the hopper in a "raised" position to allow work to be done under the hopper. Do not rely on the machine hydraulic system to keep the hopper raised.

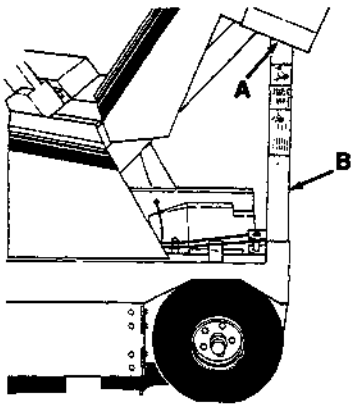
⚠ WARNING: Always engage the hopper safety support bar before working under a raised hopper. Do not rely on the machine hydraulic system to keep the hopper in the "raised" position. The hydraulic system may leak internally, allowing the hopper to lower, crushing anything under it.

TO ENGAGE HOPPER SAFETY SUPPORT BAR

1. Engage the machine parking brake and start the engine.

⚠ WARNING: Always park on a level surface and engage the parking brake before working on the machine to keep it from rolling.

2. Raise the hopper to the "fully raised" position.
3. Lift and position the hopper safety support bar in the front bumper slot.



02151

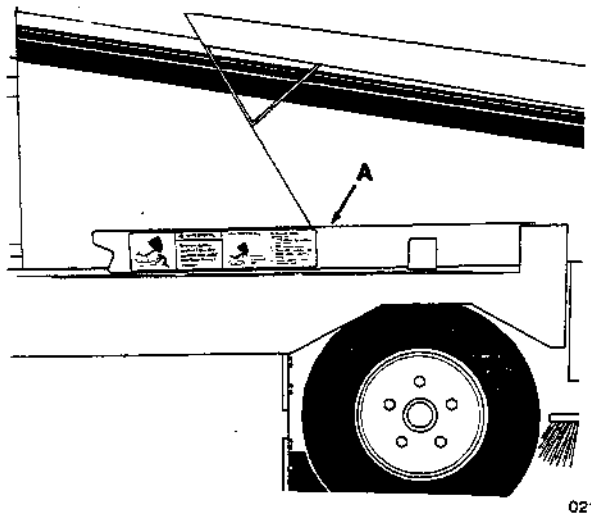
ENGAGED HOPPER SAFETY SUPPORT BAR

A. Front Bumper Slot
B. Safety Support Bar

4. Slowly lower the hopper so the front bumper rests securely on the safety support bar.
5. Turn the engine off.
6. Check the safety support bar to make sure it is securely engaged.

TO DISENGAGE SAFETY SUPPORT BAR

1. Start the engine.
2. Place the engine throttle lever in the "full" position.
3. Raise the hopper to the "fully raised" position.
4. Lower the safety support bar into its storage position.



02142

DISENGAGED HOPPER SAFETY SUPPORT BAR

A. Safety Support Bar

5. Lower the hopper.
6. Turn the engine off.

CIRCUIT BREAKERS

Circuit breakers are resetable circuit protection devices designed to stop the flow of current in the event of a circuit overload. Once tripped, circuit breakers must cool before they automatically reset. If the overload which caused the circuit breaker to trip is still present in the circuit, the circuit breaker will continue to stop current flow until the overload is corrected.

The circuit breakers are located below the steering console.

The chart below shows the various circuit breakers and the electrical components they protect.

PROTECTIVE DEVICE	RATING	CIRCUIT PROTECTED
CB-1	15 A	Filter Shaker
CB-2	15 A	Horn, Hopper Door
CB-3	15 A	Engine Ignition
CB-4	15 A	Lights
CB-5	15 A	Brush Drive, Hopper Lift

NORMAL SWEEPING OPERATION

TO START A GASOLINE POWERED MACHINE

NOTE: Before starting the machine, perform the pre-start checks.

PRE-START CHECKLIST

Check under machine for leak spots.
Check engine lubricating oil level.
Check engine air filter restriction indicator.
Check fuel level.
Check brakes and controls for proper operation.
Check service records to determine service requirements.

1. The machine operator must be in the operator's seat with the directional control pedal in the "neutral" position and with a foot on the brake pedal or with the parking brake engaged.

⚠ WARNING: Before operating the machine, make sure all safety devices are in place and operate properly. Check the foot and parking brakes and the steering control for proper operation. Do not start the machine unless you are in the operator's seat with a foot on the brake pedal or have the parking brake engaged and the directional control pedal in the "neutral" position. Failure to do so could result in severe personal injury.

2. Cold gasoline engines: Move the choke lever about three-fourths of the way forward. Pull the choke lever back after the engine has started and is running smoothly.
3. Move the throttle control lever to the "idle" position.
4. Turn the ignition switch key to the "start" position until the engine starts. Do not operate the starter for more than a few seconds at a time or after the engine has started.

NOTE: Do not operate the starter motor for more than 10 seconds at a time or after the engine has started. Allow the starter to cool between starting attempts. The starter motor may be damaged if it is operated incorrectly.

5. Allow the engine and hydraulic system to warm up three to five minutes.
6. Disengage the machine parking brake.
7. Move the throttle control lever to the "full" position, and drive the machine to the area to be swept.
8. Move the vacuum fan shut-off control lever into the "open" position.
9. Move the main brush control lever to the "normal" or "free float" position and the side brush control lever to the "down" position.
10. Sweep as required.

    Plan the sweeping in advance. Try to arrange long runs with minimum stopping and starting. Sweep debris from very narrow aisles into main aisles ahead of time. Do an entire floor or section at one time.

    Pick up oversize debris before sweeping. Flatten or remove bulky cartons from aisles before sweeping. Pick up pieces of wire, twine, string, etc., which could become entangled in brush or brush plugs.

    Allow a few inches overlap of brush paths.

    Do not turn steering wheel too sharply when the machine is in motion. The sweeper is very responsive to the movement of the steering wheel. Avoid sudden turns, except in emergencies.

    Try to sweep as straight a path as possible. Avoid bumping into posts or scraping the sides of the sweeper.

    Stop the machine vacuum when sweeping in wet conditions to avoid soaking the dust filter.

TO STOP A GASOLINE POWERED MACHINE

NOTE: Before leaving the machine, perform the post operation checks.

POST OPERATION CHECKLIST - ENGINE OPERATING

Check sweeping brush pattern for width and evenness.

1. Return the directional control pedal to the "neutral" position. Apply the brake.
2. Raise and stop the main brush and side brush.
3. Place the vacuum fan shut-off control lever in the "close" position.
4. Turn the operating lamps off if used.
5. Place the throttle control lever in the "idle" position.
6. Engage the machine parking brake.
7. Turn the ignition key switch to the "off" position. Remove the key from the ignition switch.

⚠ WARNING: Always park on a level surface, stop the engine, and engage the parking brake before leaving the machine unattended to keep it from creeping or rolling.

POST OPERATION CHECKLIST - ENGINE STOPPED

Check skirts for damage, wear, and adjustment.
Check for wire or string tangled on brushes.
Fill fuel tank.
Check for leaks.

TO START AN LPG POWERED MACHINE

NOTE: Before starting the machine, perform the pre-start checks.

PRE-START CHECKLIST

Check under machine for leak spots.
Check engine lubricating oil level.
Check engine air filter restriction indicator.
Check fuel level.
Check for LPG odor, indicating a leak.
Check for frost on LPG hoses and components.
Check to make sure liquid withdrawal LPG tank is to be used.
Check brakes and controls for proper operation.

1. Check LPG fuel tank gauge to see if there is an adequate fuel supply.
2. Slowly open the liquid service valve.

NOTE: Opening the service valve too quickly may cause the service valve check valve to stop the flow of LPG fuel. If the check valve stops the flow of fuel, close the valve, wait a few seconds, and slowly open the valve once again.

3. Cold engines in cold ambient temperatures: Open the engine cover, press the primer button on the LPG vaporizer, close the engine cover.
4. The machine operator must be in the operator's seat with the directional control pedal in the "neutral" position, a foot on the brake pedal, or with the parking brake engaged.

⚠ WARNING: Before operating the machine, make sure all safety devices are in place and operate properly. Check the foot and parking brakes and the steering control for proper operation. Do not start the machine unless you are in the operator's seat with a foot on the brake pedal or have the parking brake engaged and the directional control pedal in the "neutral" position. Failure to do so could result in severe personal injury.

5. Move the throttle control lever to the "idle" position.
6. Turn the ignition switch key to the "start" position until the engine starts. Do not operate the starter for more than 10 seconds at a time or after the engine has started.

NOTE: Do not operate the starter motor for more than 10 seconds at a time or after the engine has started. Allow the starter to cool between starting attempts. The starter motor may be damaged if it is operated incorrectly.

7. Allow the engine and hydraulic system to warm up three to five minutes.
8. Disengage the machine parking brake.
9. Move the throttle control lever to the "full" position and drive the machine to the area to be swept.
10. Move the vacuum fan shut-off control lever into the "open" position.
11. Move the main brush control lever to the "normal" or "free float" position and the side brush control lever to the "down" position.
12. Sweep as required.

    Plan the sweeping in advance. Try to arrange long runs with minimum stopping and starting. Sweep debris from very narrow aisles into main aisles ahead of time. Do an entire floor or section at one time.

    Pick up oversize debris before sweeping. Flatten or remove bulky cartons from aisles before sweeping. Pick up pieces of wire, twine, string, etc., which could become entangled in brush or brush plugs.

    Allow a few inches overlap of brush paths.

    Do not turn steering wheel too sharply when the machine is in motion. The sweeper is very responsive to the movement of the steering wheel. Avoid sudden turns, except in emergencies.

    Try to sweep as straight a path as possible. Avoid bumping into posts or scraping the sides of the sweeper.

    Stop the machine vacuum when sweeping in wet conditions to avoid soaking the dust filter.

TO STOP AN LPG POWERED MACHINE

NOTE: Before stopping the machine, perform the post operation checks.

POST OPERATION CHECKLIST - ENGINE OPERATING

Check sweeping brush pattern width and evenness.

1. Return the directional control pedal to the neutral position. Apply the brake.
2. Raise and stop the main brush and side brush.
3. Place the vacuum fan shut-off control lever in the "close" position.
4. Turn the operating lamps off if used.
5. Place the throttle control lever in the "idle" position.
6. Engage the machine parking brake.

⚠ WARNING: Always park on a level surface, stop the engine, and engage the parking brake before leaving the machine unattended to keep it from creeping or rolling.

7. Turn the ignition key switch to the "off" position. Remove the ignition key from the ignition switch.
8. Close the LPG tank liquid service valve.

POST OPERATION CHECKLIST - ENGINE STOPPED

Check skirts for damage, wear, and adjustment.
Check for wire or string tangled on brushes.
Check to make sure LPG tank service valve is closed.
Check for LPG odor, indicating a leak.
Check for frost on LPG hoses and components.
Check for leaks.

OPERATION ON GRADES

Drive the machine slowly on grades. Use the service brakes to control machine speed.

⚠ CAUTION: Always travel slowly on grades to prevent machine from becoming unstable. When going down a grade use service brakes to control speed. Do not operate machine on greater than maximum rated climb and descent angles.

The maximum rated ramp climb and descent angle is 15° with an empty hopper, and 10° with a full hopper.

HOPPER DUMPING

The hopper may be low dumped or high dumped.

The maximum dumpster height is 60 in (1525 mm). A minimum vertical clearance of 108 in (2745 mm) is required to high dump the hopper.

⚠ WARNING: Be sure adequate overhead clearance is available before attempting to high dump the hopper to avoid falling objects or electrical shock hazards.

TO DUMP HOPPER

1. Pull the side brush and main brush control levers back into the "up-off" position to stop brush rotation.
2. Pull the vacuum shut-off control lever back into the "shake filter" position to shake the dust filter and then place the lever in the "close" position to stop hopper vacuum.
3. Slowly drive the machine up to the dump site or dumpster.
4. Press the back half of the hopper position control switch into the "up" position to rotate the hopper into the "dump" position. Hold the switch down until the desired hopper height is reached.

⚠ WARNING: Do not drive the machine for any great distance or at high speed with the hopper raised to prevent machine instability.

5. Press the back half of the hopper door control switch into the "open" position to open the hopper door and empty the hopper.

NOTE: Lowering the hopper into the dumpster may help to control flying dust.

6. Press the back half of the hopper position control switch into the "up" position to allow the hopper to raise and clear the dumpster.
7. Slowly back the machine away from the dump site or dumpster.
8. Press the front half of the hopper door control switch into the "close" position to close the hopper door.
9. Press the front half of the hopper position control switch into the "down" position to lower and rotate the hopper into the "operating" position.
10. Push the vacuum shut-off control lever forward into the "open" position to vacuumize the hopper. Continue sweeping as required.

MACHINE TROUBLESHOOTING

Problem	Cause	Remedy
Excessive dusting	Dust skirts and seals worn, damaged, not adjusted properly	Replace or adjust skirts or seals
	Fusible link failure	Replace fusible link
	Dust filter clogged	Shake and/or clean or replace filter
	Vacuum fan drive belt broken	Replace drive belt
	Hopper fire door closed	Open fire door
	Vacuum fan control cable or linkage broken, not adjusted properly, or sticking	Replace and/or adjust cable or linkage
	Vacuum fan drive belt loose or broken	Adjust or replace drive belt
Poor sweeping performance	Brushes or Rotary Seal™ blades worn	Replace brushes and/or Rotary Seal™ blades
	Brushes or Rotary Seal™ not adjusted properly	Adjust brushes and/or Rotary Seal™
	Main brush drive failure	See Hydraulic System Troubleshooting: Main brush turns slowly or not at all
	Side brush drive failure	See Hydraulic System Troubleshooting: Side brush turns slowly or not at all
	Rotary Seal™ drive failure	See Hydraulic System Troubleshooting: Rotary Seal™ turns slowly or not at all
	Hopper full	Empty hopper

NOTE: For more specific electro-hydraulic system troubleshooting information, see Hydraulic System Troubleshooting.

VACUUM WAND ACCESSORY

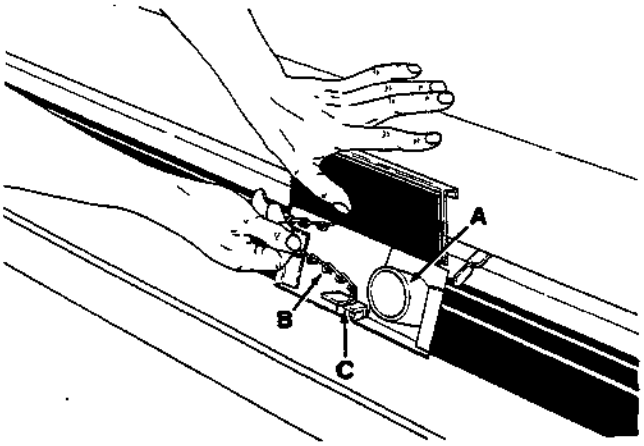
The vacuum wand accessory gives the machine the added flexibility of picking up debris not accessible to the machine. A 120 in (3050 mm) hose utilizes the machine vacuum system.

TO OPERATE VACUUM WAND

1. Stop the machine close to the area to be cleaned.
2. Place the main brush and side brush control levers in the "up-off" position to stop brush rotation.
3. Stop the engine and engage the machine parking brake.

⚠ WARNING: Always park on a level surface, stop the engine, and engage the parking brake before working on machine to keep it from creeping or rolling.

4. Open the hopper cover.
5. Remove the vacuum wand and wand hose from their storage clips.
6. Close the hopper cover.
7. Open the vacuum wand connection door and pull the fire door chain out of the chain keeper slot to divert suction to the vacuum wand.



CLOSING FIRE DOOR 02152

A. Vacuum Wand Connection
B. Fire Door Chain
C. Chain Keeper Slot

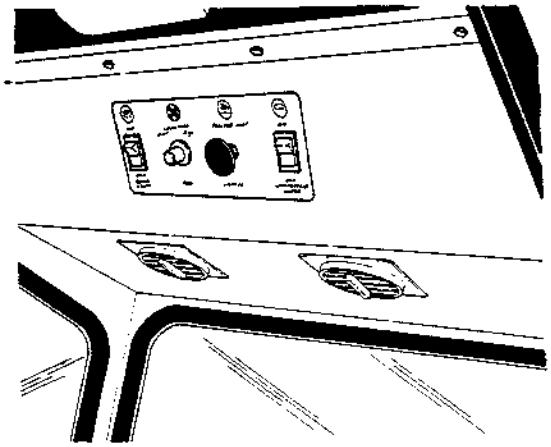
8. Push one end of the wand hose onto the wand connection.
9. Push the other end of the wand hose onto the vacuum wand.
10. Start the engine.
11. Move the throttle control lever to the "full" position.
12. Move the vacuum fan shut-off control lever forward into the "open" position to start the vacuum.
13. Vacuum the area as required.
14. When finished, pull the vacuum fan shut-off control lever back and to the left, into the "close" position to stop the vacuum.
15. Place the throttle control lever in the "idle" position.
16. Stop the engine.
17. Pull the vacuum hose out of the vacuum hose connection.
18. Disconnect the wand hose from the vacuum wand.
19. Open the wand connection door; then open the fire door by pulling the fire door chain up and sliding it into the chain keeper slot.

NOTE: The fire door must be reopened to allow the hopper vacuum system to operate.

20. Open the hopper cover and return the vacuum wand and wand hose to their storage clips on the bottom of the hopper cover.
21. Close the hopper cover.

CAB PRESSURIZER

The cab pressurizer is included in the cab accessory. The pressurizer includes a dome light, defroster/circulation fan and vent controls, windshield wiper control, and heater control for machines equipped with the cab heater accessory.



CAB PRESSURIZER 02154

TRANSPORTING MACHINE

PUSHING OR TOWING MACHINE

The machine may be pushed from the front or the rear, using the bumpers provided, only after placing the rear wheel on a dolly.

The machine may be towed in either direction. Do not pull on the front bumper—pull on the hopper pivot tube.

ATTENTION! Do not push or tow the machine without placing the rear wheel on a dolly; the machine hydraulic system may be damaged.

MACHINE JACKING

The machine may be jacked up for service at the designated locations. Use a jack of adequate capacity and good working condition. Always stop the machine on a flat, level surface and block the tires before jacking the machine up. The front jacking locations are on the flat bottom edge of the machine frame in front of the front tires.

The rear jacking location is the middle flat bottom edge of the rear bumper.

TO JACK UP MACHINE

1. Empty the debris hopper.
2. Stop the engine and engage the machine parking brake.

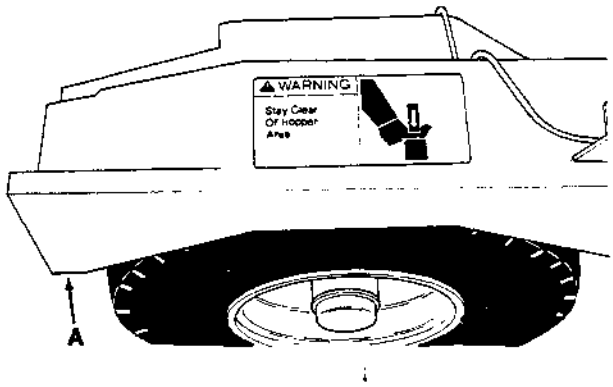
⚠ WARNING: Always park on a level surface, stop the engine, and engage the parking brake before working on the machine to keep it from creeping or rolling.

3. Block the tires, which are not being jacked up, in order to secure the machine position.

⚠ WARNING: Always block the machine tires before jacking the machine up to keep it from rolling off jack.

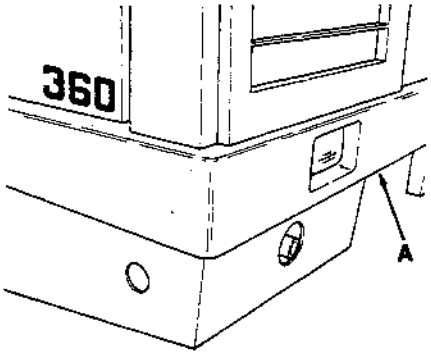
4. Use a jack of adequate capacity to raise the machine. Jack up the machine only at the designated locations.

⚠ WARNING: Jack machine up only at the designated locations to keep it from tipping.



FRONT JACKING LOCATION 02141

A. Jacking Location



REAR JACKING LOCATION 02155

A. Jacking Location

5. Block machine up with jack stands or similar devices in the designated locations to secure the machine.

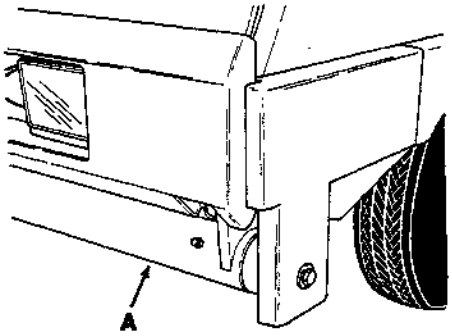
⚠ WARNING: Always use jack stands or similar devices to hold the machine up. Scissors, ratchet, cable, or hydraulic-type jacks may slip or leak internally, allowing the machine to lower or fall, crushing anything under it.

6. Lower the machine onto the jack stands.
7. Check to make sure the machine is secure.
8. Service the machine as required.
9. When finished servicing the machine, raise the machine off the jack stands.
10. Remove the jack stands from under the machine.
11. Lower the machine.
12. Remove the blocks from the tires.

MACHINE TIE-DOWNS

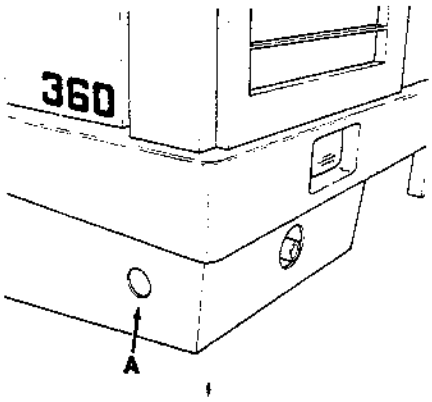
The machine may be tied down at each of the four corners of the machine at the locations specified.

To tie the machine down, use the hopper pivot tube or front wheel pocket holes in the front and the holes in the lower rear machine frame in the back.



FRONT TIE-DOWN LOCATION 02156

A. Hopper Pivot Tube



REAR TIE-DOWN LOCATION 02155

A. Tie-Down Hole

When transporting the machine on a trailer or in a truck, be sure to engage the machine parking brake and block the machine tires to prevent the machine from rolling.

MACHINE STORAGE

STORING MACHINE

When storing the machine for extended periods of time, the following procedures must be followed to lessen the chance of rust, sludge, and other undesirable deposits from forming.

1. Empty the debris hopper.
2. Change engine oil.
3. Place the main brush height control lever in the "raise" position.
4. Park the machine in a cool and dry area.
5. Stop the engine.
6. Fill the hydraulic reservoir with hydraulic fluid to the full mark on the dipstick to prevent excessive condensation from forming in the reservoir.

7A. To store the machine 30 to 90 days:

1. Remove the spark plugs.
2. Pour 3 oz (90 cc) of clean engine oil into each spark plug hole.
3. Remove the ignition coil high tension wire. Operate the engine starter motor for at least a dozen revolutions. This distributes the oil over the cylinder walls.

NOTE: Before preparing the engine for storage, allow it to cool down to the surrounding temperature. Oil adheres to cold metal surfaces much better than hot surfaces.

4. Replace the high tension coil wire and spark plugs.
5. Drain the gasoline from the carburetor bowl by removing the carburetor bowl drain plug.
6. Replace the carburetor drain plug.

7B. To store the machine 90 days to 6 months:

1. Remove the spark plugs.
2. Pour 3 oz (90 cc) of SAE 30 or SAE 40 engine oil into each of the spark plug holes.
3. Remove the ignition coil high tension wire. Operate the engine starter for at least a dozen revolutions. This distributes the oil over the cylinder walls. Replace the spark plugs.
4. Drain the engine oil from the engine oil pan.
5. Drain the coolant from the radiator and engine block.
6. Close the engine cooling system drain cocks.
7. Drain gasoline from the carburetor, fuel tank, and the fuel lines.
8. Seal the air cleaner inlet and the exhaust outlet with weatherproof masking tape.
9. Tighten the engine oil filler cap, the fuel tank cap, and the radiator cap to make certain they are securely in place.

SECTION 3
MAINTENANCE

CONTENTS

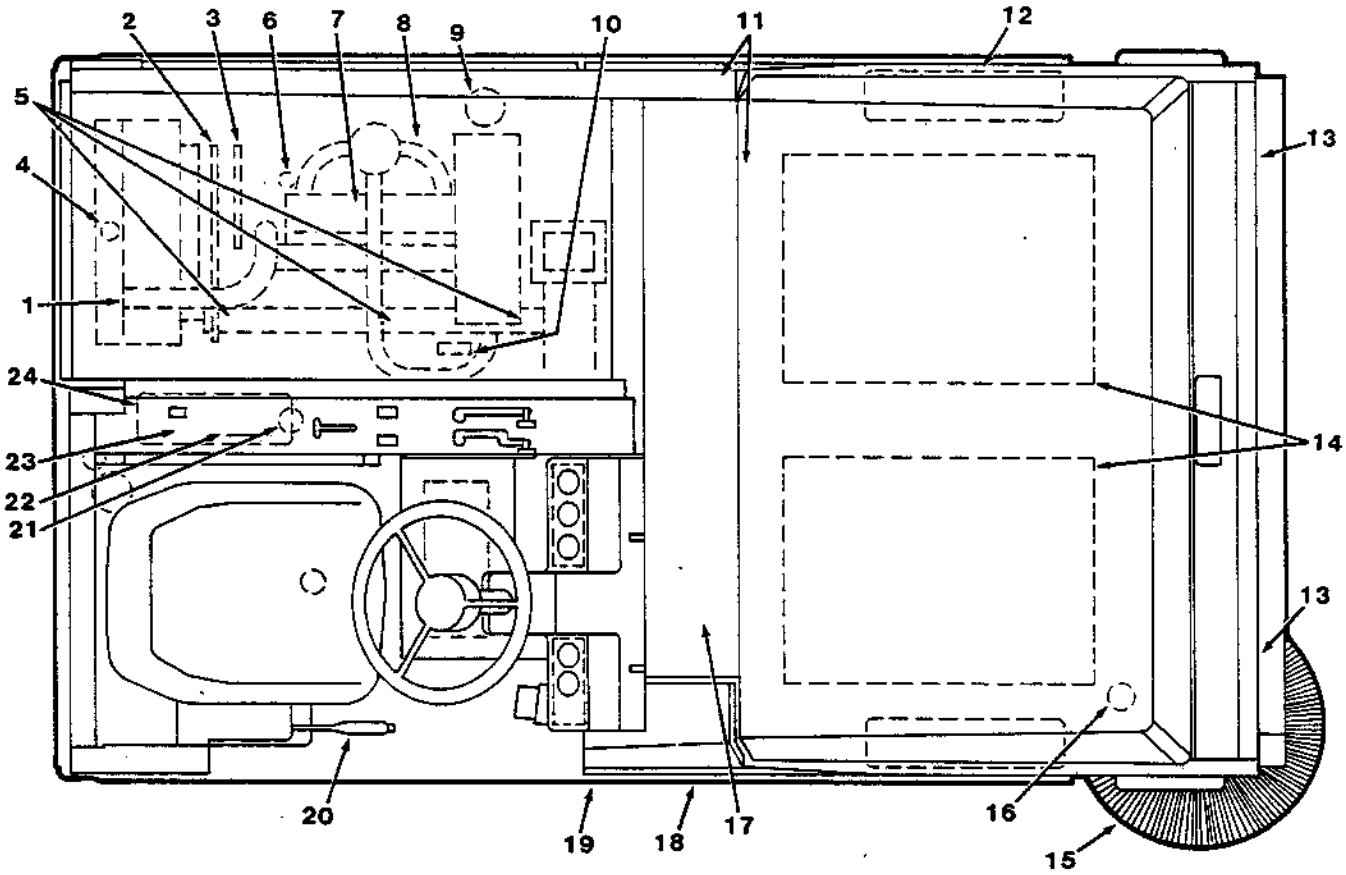
CONTENTS

RECOMMENDED FIRST 50-HOUR MACHINE INSPECTION

After the first 50 hours of operation, the following procedures are recommended:

1. Check the brush pattern for correct brush adjustment.
2. Change the hydraulic fluid filter.
3. Check distributor ignition timing.
4. Torque the cylinder head bolts to the proper specification.
5. Perform all 50-hour interval lubrication and maintenance procedures listed in the Maintenance chart.

MAINTENANCE CHART



MAINTENANCE LOCATIONS

02157

MAINTENANCE CHART

Interval	Key	Description	Procedure	Lubricant	No. of Service Points
Daily	10	Engine air filter restriction indicator	Check for red restriction indicator	-	1
	8	Engine crankcase	Check oil level	EO	1
	19	Brush skirts	Check for damage, wear, and adjustment	-	7
	18	Main brush	Check for damage, wear, and adjustment	-	1
	18	Rotary Seal™	Check for damage, wear, and adjustment	-	1
	15	Side brush	Check for damage, wear, and adjustment	-	1
50 Hours	8	Engine crankcase	Change oil	EO	1
	6	Engine oil filter	Change filter element	-	1
	18	Main brush	Rotate end-for-end	-	1
	5	Vacuum fan shaft	Lubricate	SPC	3
100 Hours	11	Dust seals	Check for wear or damage	-	15
	14	Hopper dust filter(s)	Inspect and clean or replace	-	1 (2)
	1	Radiator	Check coolant level	WG	1
			Clean exterior	-	1
	23	Hydraulic fluid reservoir	Check fluid level	HYDO	1
	12	Front tires	Check pressure	-	2
	24	Rear tire	Check pressure	-	1
200 Hours	2	Vacuum fan belt	Check tension	-	1
	3	Alternator belt	Check tension	-	1
	4	Engine fan belt	Check tension	-	1
	16	Side brush pivot	Lubricate	MPGM	1
	20	Parking brake	Check adjustment	-	1
	21	Rear wheel support bearing	Lubricate	MPGM	1
	13	Hopper pivot	Lubricate	MPGM	2
	22	Steering cylinder end	Lubricate	MPGM	1
400 Hours	17	Brake master cylinder	Check fluid level	BF	1
	7	Engine	Check and adjust valve clearance	-	8
			Check and adjust idle speed	-	1
			Check and adjust idle mixture	-	1
			Clean or replace and adjust spark plugs	-	4
			Clean or replace and adjust distributor points	-	1
			Check and adjust timing	-	1
			Replace PCV valve	-	1
			Clean PCV hoses, tubes, and fittings	-	-
			Lubricate distributor felt	EO	1
	23	Hydraulic fluid reservoir	Change hydraulic fluid	HYDO	1
	9	Hydraulic fluid filter	Change filter element	-	1

Interval	Key	Description	Procedure	Lubricant	No. of Service Points
800 Hours	12	Front wheel bearings	Repack wheel bearings	MPGM	2
	7	Engine	Torque intake manifold bolts	-	5
	1	Cooling system	Flush	WG	1
	23	Hydraulic fluid reservoir breather	Replace	-	1

HYDO - Tennant Company or approved hydraulic fluid
EO - Engine oil
WG - Water and permanent-type ethylene glycol anti-freeze, one-to-one ratio
MPGM - Multipurpose, water resistant, lithium base, moly-disulphide EP grease
SPC - Special lubricant, Lubriplate EMB grease, TENNANT® Part Number 01433-1
BF - Brake fluid

NOTE: More frequent intervals may be required in extremely dusty conditions.

LUBRICATION

ENGINE

Check the engine oil level daily. Change the engine oil and oil filter after every 50 hours of operation. Use only SAE-SE rated engine oil.

The following SAE-SE rated oil grades are recommended for engines during changing seasonal temperatures:

MULTI-VISCOSITY OILS

Below 32°F (Below 0°C)	-10° to 90°F (-23° to 32°C)	-10° to above 90°F (-23° to above 32°C)	Above 10°F (Above -12°C)
5W 30	10W 30	10W 40	20W 40

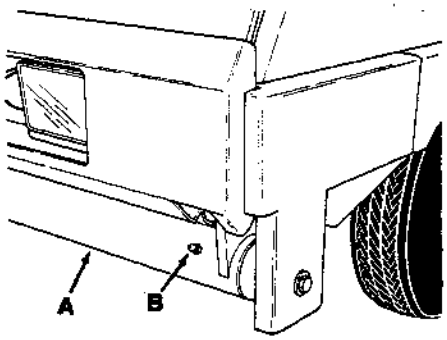
SINGLE VISCOSITY OILS

-10° to 32°F (-23° to 0°C)	10° to 60°F (-12° to 16°C)	32° to 90°F (0° to 32°C)	Above 60°F (Above 16°C)
10W	20W 20	30	40

The engine oil capacity is 3.5 qt (3.3 L) including the oil filter. Add three drops of oil to the distributor shaft oil wick after every 100 hours of operation.

HOPPER PIVOT

The hopper pivot is near the front of the machine. Lubricate the pivot by applying a multipurpose, water resistant, lithium base, moly-disulphide EP grease to the two grease fittings after every 400 hours of operation.

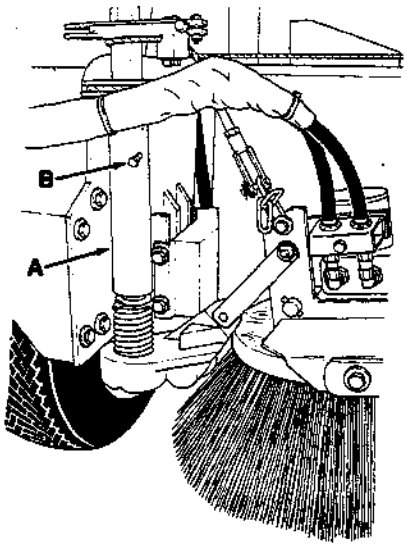


HOPPER PIVOT 02156

A. Hopper Pivot
B. Grease Fitting

SIDE BRUSH PIVOT

The side brush mechanism pivots on a shaft near the inside right front corner of the machine. Lubricate the shaft by applying a multipurpose, water resistant, lithium base, moly-disulphide EP grease to the grease fitting after every 200 hours of operation.

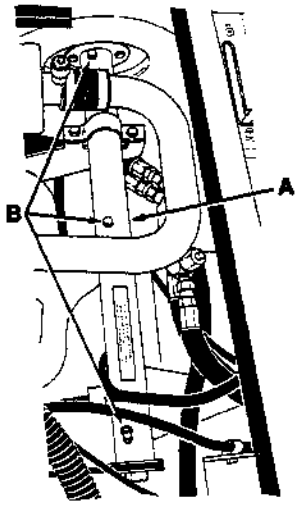


SIDE BRUSH PIVOT 02158

A. Side Brush Pivot
B. Grease Fitting

VACUUM FAN SHAFT

The vacuum fan shaft is supported by three bearings. Each of these bearings should be lubricated by applying one pump of Lubriplate EMB grease (TENNANT® Part No. 01433-1) from a hand grease gun to its grease fitting after every 50 hours of operation. After lubricating the bearings, wipe off all excess grease and replace the grease fitting caps.

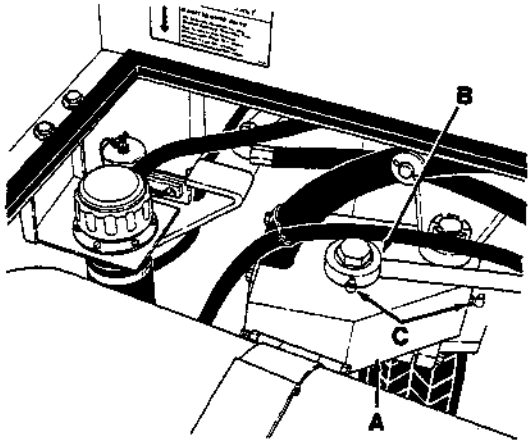


VACUUM FAN SHAFT 02159

A. Vacuum Fan Shaft Housing
B. Grease Fitting

REAR WHEEL SUPPORT

The rear wheel support pivots the rear wheel. Lubricate the rear wheel support bearing by applying a multipurpose, water resistant, lithium base, moly-disulphide EP grease to the grease fitting after every 400 hours of operation.



REAR WHEEL SUPPORT AND STEERING 02160

A. Rear Wheel Support
B. Steering Cylinder End
C. Grease Fitting

STEERING CYLINDER END

The steering cylinder end pivots the rear wheel support. Lubricate the cylinder end by applying a multipurpose, water resistant, lithium base, moly-disulphide EP grease to the grease fitting after every 400 hours of operation.

FRONT WHEEL BEARINGS

The front wheel bearings support the front half of the machine. They should be repacked with multipurpose, water resistant, lithium base, moly-disulphide EP grease after every 800 hours of operation.

HYDRAULIC FLUID

TENNANT® Hydraulic Fluid is a specially compounded oil with the following features not found in many hydraulic fluids:

1. Flat viscosity curve.
2. Additives to prevent corrosion.
3. Additives to prevent oxidation.
4. Rust inhibitors.
5. Foam suppressors.

These features restrict foaming of the hydraulic fluid and provide a high standard of lubrication to the components.

TENNANT® HYDRAULIC FLUID VISCOSITY SPECIFICATIONS

	TENNANT® Hyd. Fluid No. 32397 (HP1040)	TENNANT® Hyd. Fluid No. 32398 (HP2060)
SUS @ 100° F (38° C)	404-445	940-1010
SUS @ 210° F (99° C)	78-84	122-130

TENNANT® Hydraulic Fluids have a very flat viscosity curve (synonymous with "high viscosity index"). The flat viscosity curve means that the thickness of the fluid is very constant over wide temperature ranges.

Hydraulic fluid with the viscosity rating of HP1040 should be used in machines that are operated in areas which have ambient temperatures up to 90° F (32° C). Use the HP2060 rated hydraulic fluid in areas which have ambient temperatures above 90° F (32° C).

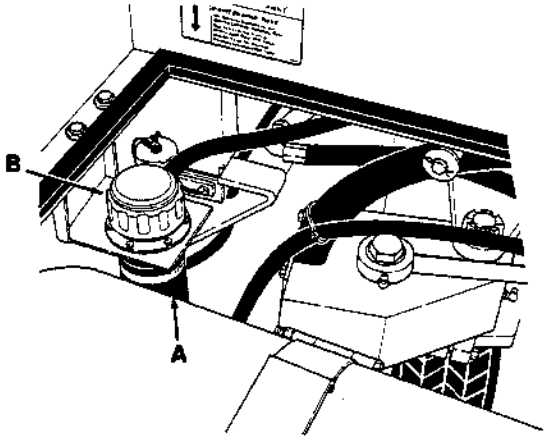
ATTENTION! If a locally-available hydraulic fluid is preferred, or if products of only one oil company are used, the hydraulic fluid used must match closely the viscosity specifications given in the chart for TENNANT® Hydraulic Fluid, as well as the other features described. Do not substitute automatic transmission fluid for hydraulic fluid.

ATTENTION! Hydraulic components depend on system hydraulic fluid for internal lubrication. If dirt or other contaminants are allowed to enter the hydraulic system, malfunctions, accelerated wear, and damage will result.

HYDRAULIC FLUID RESERVOIR

Hydraulic fluid is stored in the hydraulic fluid reservoir. The reservoir holds up to 5.3 gal (20 L) of hydraulic fluid. The reservoir is located under the operator seat.

The reservoir is equipped with a breather-filler cap and fluid level dipstick mounted on the filler neck. See Hydraulic Fluid Reservoir Breather for breather service information.



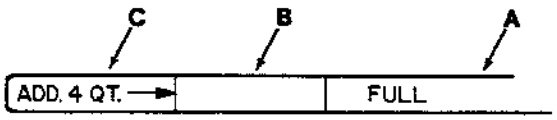
02160

HYDRAULIC FLUID RESERVOIR BREATHER-FILLER CAP

A. Filler Neck
B. Breather-Filler Cap

The hydraulic fluid level dipstick is built into the breather-filler cap. The end of the dipstick is marked with "full" and "add" levels. This indicates the level of hydraulic fluid in the reservoir.

Check the hydraulic fluid level after every 100 hours of operation. It should be above the "add" marks on the dipstick, but not above the "full" mark when the hydraulic fluid is warm.



HYDRAULIC FLUID LEVEL DIPSTICK 02164

A. Dipstick
B. Full Range
C. Add Range

Do not overfill the hydraulic fluid reservoir. The hydraulic fluid expands as it heats to its normal operating temperature. Always allow for expansion when filling the reservoir.

ATTENTION! Do not overfill the hydraulic fluid reservoir or operate the machine with a low level of hydraulic fluid in the reservoir. Damage to the machine hydraulic system may result.

Drain, flush, and refill the hydraulic fluid reservoir with hydraulic fluid after every 400 hours of operation.

TO DRAIN THE HYDRAULIC FLUID RESERVOIR

1. Stop the engine and engage the machine parking brake.

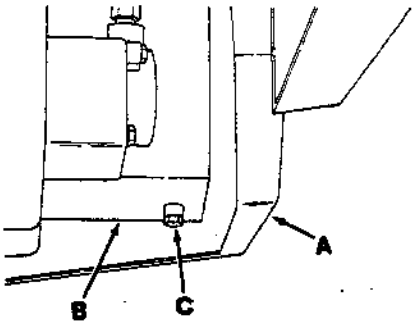
⚠ WARNING: Always park on a level surface, stop the engine, and engage the parking brake before working on the machine to keep it from creeping or rolling.

2. Allow the hydraulic fluid to cool.

⚠ WARNING: Always allow the hydraulic fluid to cool before draining. Hot fluid can cause severe burns.

3. Remove the reservoir drain plug located on the bottom of the reservoir to drain the hydraulic fluid. Discard the used hydraulic fluid.

NOTE: Always change the hydraulic fluid filter when draining the hydraulic fluid reservoir.



02165

HYDRAULIC FLUID RESERVOIR DRAIN PLUG

A. Right Rear of Machine
B. Hydraulic Fluid Reservoir
C. Drain Plug

4. Flush the reservoir with clean hydraulic fluid or suitable solvent. Do not use gasoline, kerosene, or diesel fuel.
5. Reinstall the reservoir drain plug.

TO FILL THE HYDRAULIC FLUID RESERVOIR

1. Raise the operator seat.
2. Remove the reservoir breather-filler cap.
3. Pour 6 gal (23 L) of new, approved hydraulic fluid through a 200 mesh screened funnel and into the reservoir filler neck.

ATTENTION! Use only new, approved hydraulic fluid to fill the hydraulic fluid reservoir.

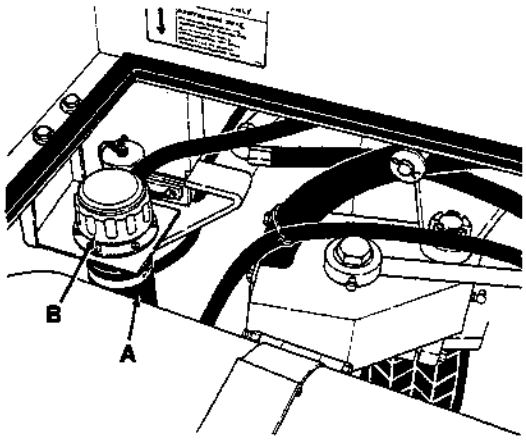
4. Check the hydraulic fluid level in the reservoir with the reservoir dipstick.
5. Add hydraulic fluid until the level in the reservoir is between the "add" and the "full" range. Do not overfill.

NOTE: Do not overfill the hydraulic fluid reservoir. As hydraulic fluid heats to its normal operating temperature, it expands. Always allow for this expansion when filling the hydraulic fluid reservoir.

6. Place the reservoir breather-filler cap securely on the reservoir filler neck.
7. Lower the operator seat.
8. Start engine and operate all of the hydraulic components. Then recheck the hydraulic fluid level.

HYDRAULIC FLUID RESERVOIR BREATHER

The hydraulic fluid reservoir is equipped with a breather. The breather relieves excess atmospheric pressure or vacuum in the reservoir. The breather is mounted on the hydraulic fluid reservoir filler neck under the operator seat. The breather should be replaced after every 800 hours of operation.



RESERVOIR BREATHER-FILLER CAP 02160

A. Filler Neck
B. Breather-Filler Cap

HYDRAULIC FLUID FILTER

The machine hydraulic system is kept clean to a level of 10 microns by a hydraulic fluid filter. The hydraulic fluid filter is located in the left front of the machine engine compartment.

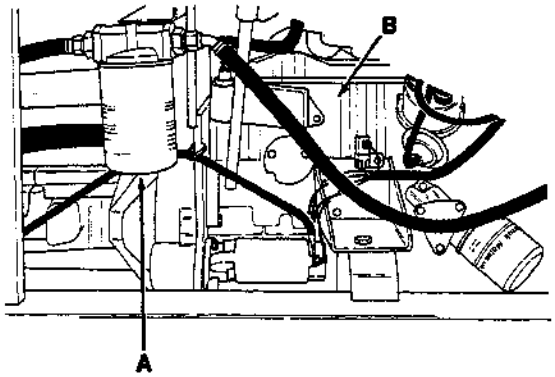
Replace the hydraulic fluid filter element after the first 50 hours of operation and then after every 400 hours of operation.

TO REPLACE HYDRAULIC FLUID FILTER ELEMENT

1. Stop the engine and engage the machine parking brake.

⚠ WARNING: Always park on a level surface, stop the engine and engage the parking brake before working on the machine to keep it from creeping or rolling.

2. Open the side engine access door.



HYDRAULIC FLUID FILTER 02166

A. Hydraulic Fluid Filter Element
B. Engine

3. Unthread and discard the hydraulic fluid filter element.

NOTE: Discard all hydraulic fluid drained from the system. Drained hydraulic fluid may contain foreign material harmful to the hydraulic system.

4. Apply a thin coat of hydraulic fluid to the seal of the new hydraulic fluid filter element.
5. Thread and hand tighten the new hydraulic fluid filter element on the filter head.
6. Operate the machine and check for leaks. Correct any leaks found.
7. Check the hydraulic fluid reservoir level and fill as required.
8. Close the side engine access door.

HYDRAULIC PUMPS

The machine propelling pump is a variable displacement hydraulic piston pump. It is driven by the engine via a chain coupling.

The machine accessories pump is a hydraulic gear pump. It is tandem mounted to the hydraulic piston pump.

After repairing or replacing a hydraulic pump, and system contamination is likely, change the hydraulic fluid in the reservoir and the hydraulic fluid filter. Then the proper start and break-in procedure must be followed to prevent possible damage to the pump. To Start and Break-In Hydraulic Pump outlines the procedure.

TO START AND BREAK-IN HYDRAULIC PUMP

1. Engage the machine parking brake and block the front tires of the machine.

⚠ WARNING: Always engage the parking brake and block the machine tires before jacking the machine up to keep it from rolling or falling off jack.

2. Jack up the rear of the machine at the designated locations.

⚠ WARNING: Jack the machine up only at the designated locations to keep it from falling off jack.

3. Block up the machine with jack stands in the designated locations. Make sure the rear tire clears the floor by 2 in (50 mm) and all obstacles within a 24 in (610 mm) radius.
4. Fill the hydraulic fluid reservoir with 6 gal (23 L) of new, approved hydraulic fluid.
5. Fill the hydraulic pump through the case drain port with hydraulic fluid.
6. Remove the engine coil wire from the engine distributor.
7. Operate the engine starter motor three 10 second periods.
8. Replace the engine coil wire.
9. Start the engine and operate it at a low idle for two minutes.
10. Press the directional control pedal one-half of its travel in the "forward" direction while also doing the following:
    a. Operate the main brush and side brush for one minute.
    b. Turn the steering wheel fully to the left and right five times.
11. Stop the engine.
12. Raise the rear of the machine, remove the jack stands, and lower the machine.
13. Fill the hydraulic fluid reservoir with new, approved hydraulic fluid.
14. Check the hose routings to be sure the hoses do not contact any moving, hot, or sharp surfaces.
15. Replace the hydraulic fluid filter after the first hour of operation.

DIRECTIONAL CONTROL PEDAL

The directional control pedal controls the flow of hydraulic fluid to the hydraulic drive motor. The pedal has three positions—"forward," "neutral," and "reverse." The "forward" and "reverse" positions send hydraulic fluid to the drive motor to propel the machine.

The "neutral" position is the position in which the propelling pump sends no hydraulic fluid to the propelling motor. The machine should not creep when the "neutral" position is correctly adjusted. Adjust the control pedal linkages whenever the machine creeps or after replacing the hydraulic propelling pump or pump linkages. The control pedal linkages should also be adjusted whenever the reverse speed seems excessive or inadequate.

TO ADJUST DIRECTIONAL CONTROL PEDAL LINKAGE

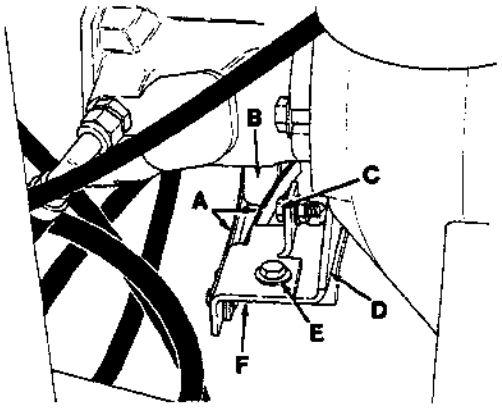
1. Stop the engine and engage the machine parking brake.

⚠ WARNING: Always park on a level surface, stop the engine, and engage the parking brake before working on the machine to keep it from creeping or rolling.

2. Block the machine tires and jack up the rear of the machine at the designated location.

⚠ WARNING: Jack up the machine only at the designated locations to keep it from falling off jack.

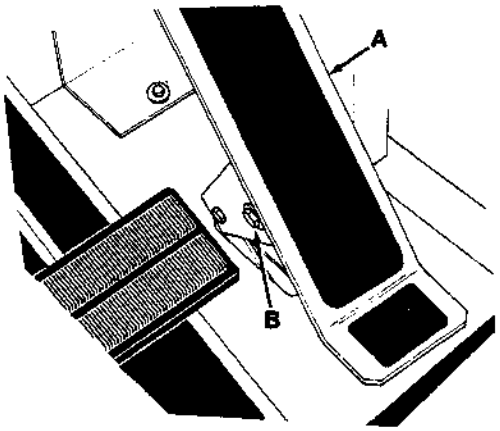
3. Block up the machine with jack stands in the designated locations. Make sure the rear tire clears the floor by 2 in (50 mm) and all obstacles within a 24 in (610 mm) radius.
4. Loosen the centering spring bracket retention bolts and adjustment bolt jam nut.



CENTERING SPRINGS 02167

A. Centering Springs
B. Pump Pintle Arm
C. Adjustment Bolt
D. Stationary Bracket
E. Retaining Bolt
F. Spring Bracket

5. Adjust the position of the spring bracket and adjustment bolt so the hydraulic pump pintle arm is held in a vertical position.
6. Snug the retention bolts.
7. Start the engine.
8. Move the directional control pedal into the "forward" position and release it. The rear wheel should stop rotating as soon as the pedal is released. Adjust the spring bracket as required.
9. Move the directional control pedal into the "reverse" position and release it. The rear wheel should stop rotating as soon as the pedal is released. Adjust the spring bracket as required.
10. Stop the engine. Tighten the bolts.
11. Raise the rear of the machine, remove the jack stands, and lower the machine.
12. Loosen the bolt connecting the directional control pedal to the control linkage.



DIRECTIONAL CONTROL PEDAL 02168

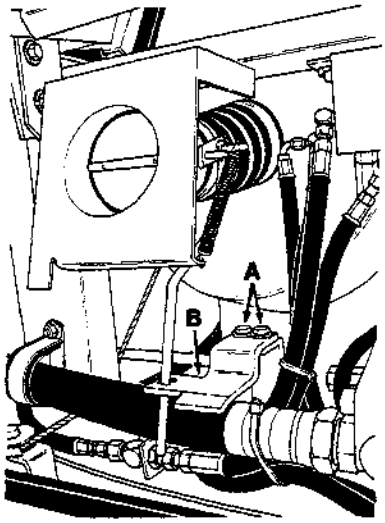
A. Control Pedal
B. Adjustment Bolt

13. Adjust the position of the directional control pedal so the linkage stops will restrict the pedal movement when it is pressed forward and so it will contact the floor when it is pressed backward. The backward travel should be restricted so the machine will not travel faster than 2.5 mph (4 km/h) in reverse.
14. Tighten the directional control pedal bolt.

SPEED LIMITER

The machine speed limiter limits the maximum speed the machine can travel when the hopper is raised. This is done by limiting the travel of the pump pintle arm. The speed limiter should be adjusted whenever the pump control linkage, vacuum fan intake, or hopper is adjusted. The machine should not travel more than 2 mph (3.2 km/h) with the hopper raised.

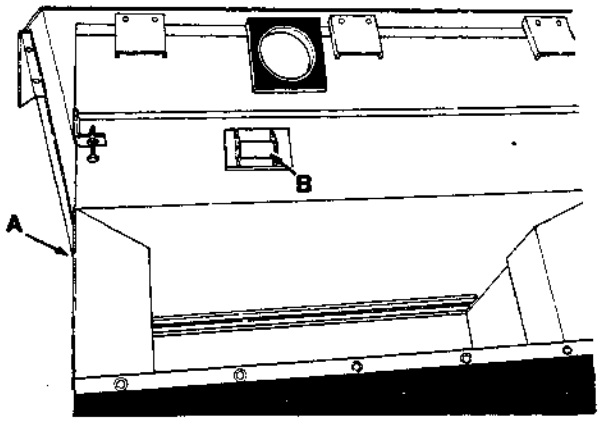
The speed limiter has two adjustments—the speed limiter bracket and the hopper roller. The speed limiter bracket is pushed down by the hopper roller when the hopper is lowered. The bracket is mounted in slots and should be positioned in the path of the hopper roller.



SPEED LIMITER BRACKET 02169

A. Retention Bolt
B. Speed Limiter Bracket

The hopper roller is also mounted in slots and should be positioned so it will strike the speed limiter bracket. The slots also allow the hopper roller to be adjusted so it will press the speed limiter bracket down far enough to engage the pump pintle arm limiting bracket.

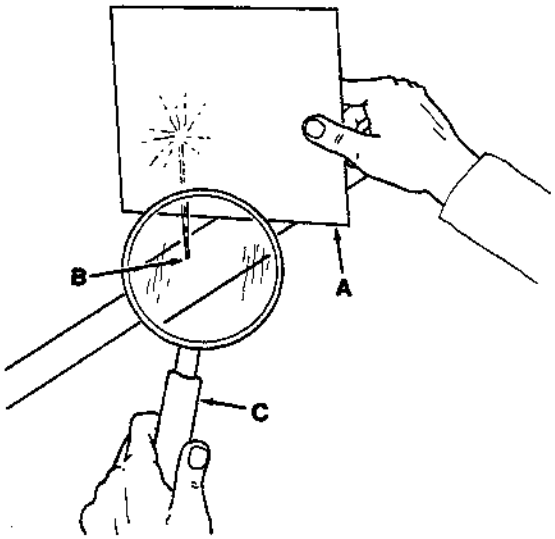


HOPPER ROLLER 02170

A. Hopper
B. Hopper Roller

HYDRAULIC FLUID LEAKS

Fluid escaping at high pressure from a very small hole can be almost invisible and can cause serious injuries. Use a piece of cardboard or wood, rather than hands, to search for suspected leaks.

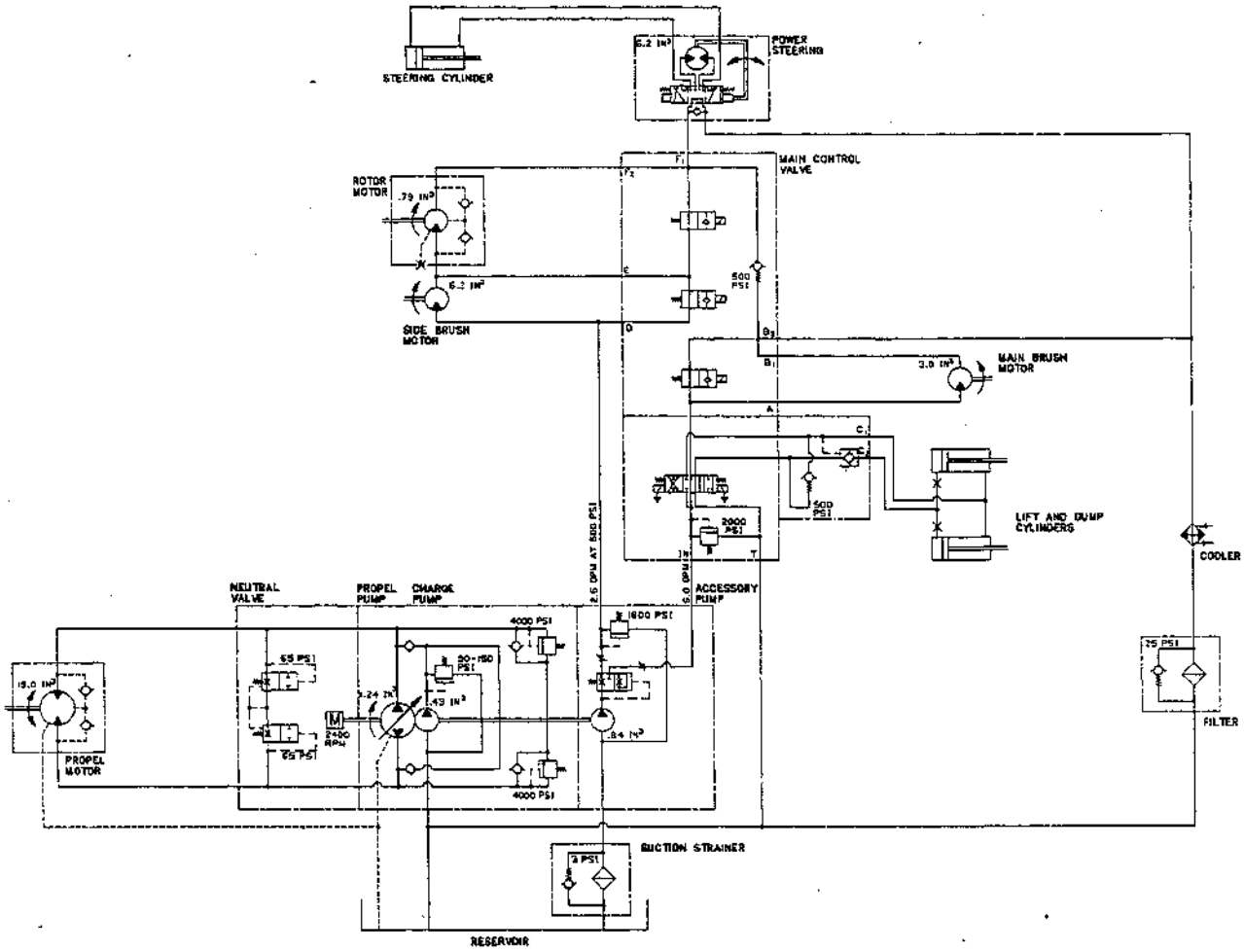


HYDRAULIC PINHOLE LEAK 00002

A. Cardboard
B. Pinhole Leak
C. Magnifying Glass

If injured by escaping hydraulic fluid, see a doctor at once. Serious infection or reaction can develop if proper medical treatment is not administered immediately.

⚠ WARNING: Escaping hydraulic fluid under pressure can have sufficient force to penetrate the skin, causing serious personal injury. Before starting engine, be sure all connections are tight and that lines, pipes, and hoses are not damaged.



HYDRAULIC SCHEMATIC 02171

HYDRAULIC SYSTEM TROUBLESHOOTING

The machine utilizes three hydraulic fluid pressure sources to drive nine individual hydraulic circuits. The pressure sources are the variable displacement hydraulic piston pump, and the hydraulic gear pump with an integral flow divider which provides a 2.5 gpm (9.5 L/min) primary flow and 6 gpm (23 L/min) secondary flow.

The variable displacement piston pump drives the forward and reverse propelling circuits. The primary flow from the gear pump drives the left and right steering circuits, the Rotary Seal™ circuit, and the side brush and Rotary Seal™ circuit. The secondary flow from the gear pump drives the hopper lifting and lowering circuits and the main brush circuit.

A combination of mechanical and electrical devices control the hydraulic system. The following diagrams illustrate the specific mechanical or electrical means used to control the hydraulic circuits. Refer to the individual system diagrams and explanations to determine system flows. All specifications given are typical with the engine operating at full throttle.

PROPELLING-FORWARD CIRCUIT

When the directional control pedal is pressed into the "forward" position, the variable displacement propelling pump directs hydraulic fluid to the drive motor to propel the machine forward. The hydraulic fluid then returns to the pump. This is basically a closed loop circuit.

The propelling pump and drive motor are both equipped with case drains to bleed internal hydraulic fluid leakage to the reservoir to prevent excess pressure build up. Loss of hydraulic fluid to the reservoir is made up by pump suction from the hydraulic fluid filter.

TYPICAL CIRCUIT SPECIFICATIONS

Level ground:

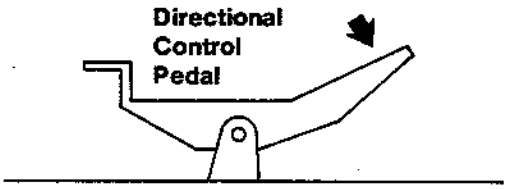
Motor inlet pressure - 200 to 500 psi (1380 to 3450 kPa)
Volume - 13 gpm (49 L/min) @ maximum speed

15° ramp:

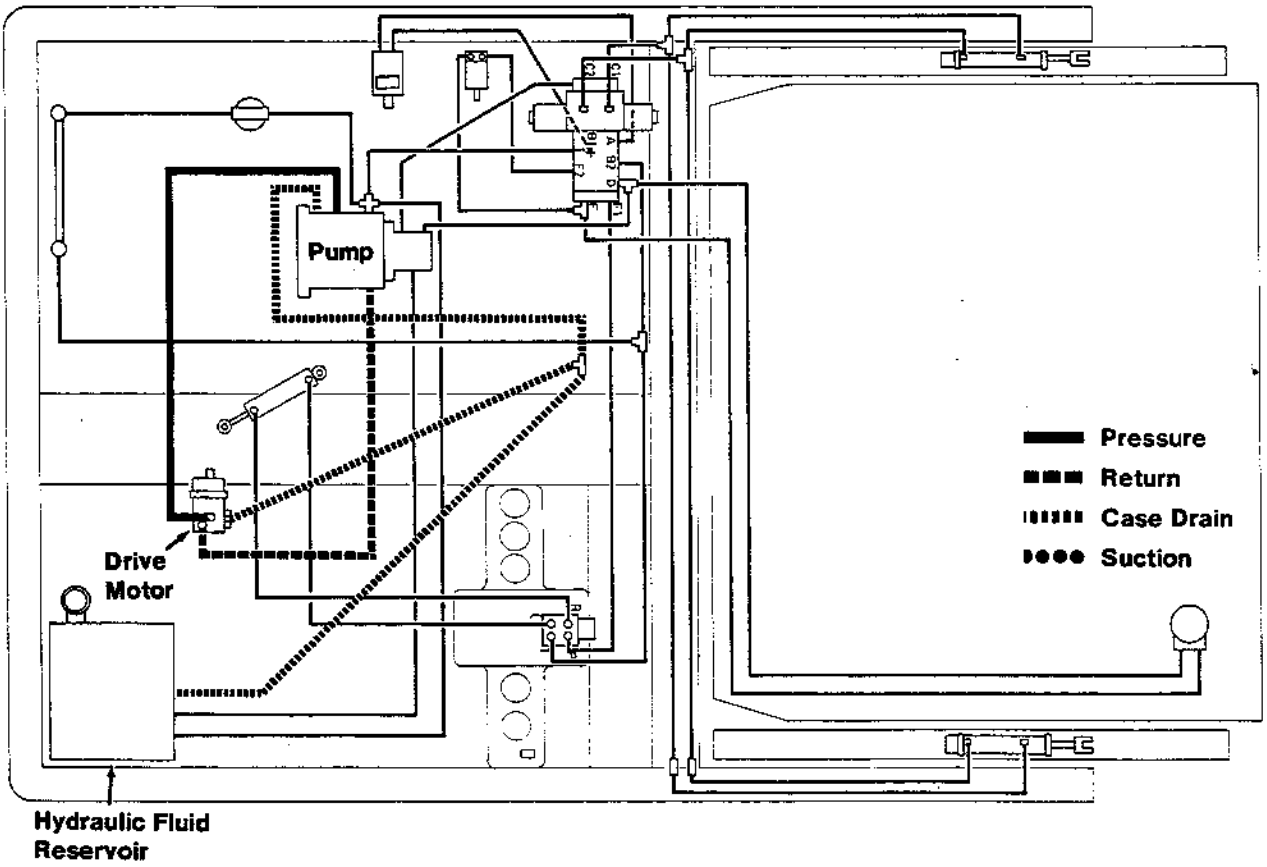
Motor inlet pressure - 4000 to 4400 psi (27,580 to 30,340 kPa)
Volume @ maximum speed - 4.5 gpm (17 L/min)

CIRCUIT TROUBLESHOOTING

Problem	Cause	Remedy
Machine travels slowly or not at all	Parking brake engaged	Release parking brake
	Control linkage broken or not adjusted properly	Replace and/or adjust linkage
	Relief valve stuck open (leaking)	Clean or replace relief valve - one for forward, one for reverse
	Motor failure	See Hydraulic Components Troubleshooting
	Pump failure	See Hydraulic Components Troubleshooting
	Hydraulic fluid level low	Fill hydraulic fluid reservoir
	Brakes dragging	Adjust brakes



DIRECTIONAL CONTROL PEDAL IN "FORWARD" POSITION 02208



PROPELLING-FORWARD CIRCUIT HYDRAULIC FLOWS 02199

PROPELLING-REVERSE CIRCUIT

When the directional control pedal is pressed into the "reverse" position, the variable displacement propelling pump directs hydraulic fluid to the drive motor to propel the machine backward. The hydraulic fluid then returns to the pump. This is basically a closed loop circuit.

The propelling pump and drive motor are both equipped with case drains to bleed internal hydraulic fluid leakage to the reservoir to prevent excess pressure build up. Loss of the hydraulic fluid to the reservoir is made up by pump suction from the hydraulic fluid filter.

TYPICAL CIRCUIT SPECIFICATIONS

Level ground:

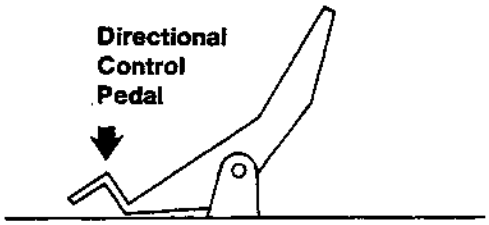
Motor inlet pressure - 200 to 500 psi (1380 to 3450 kPa)
Volume @ maximum limited speed - 6 gpm (23 L/min)

15° ramp:

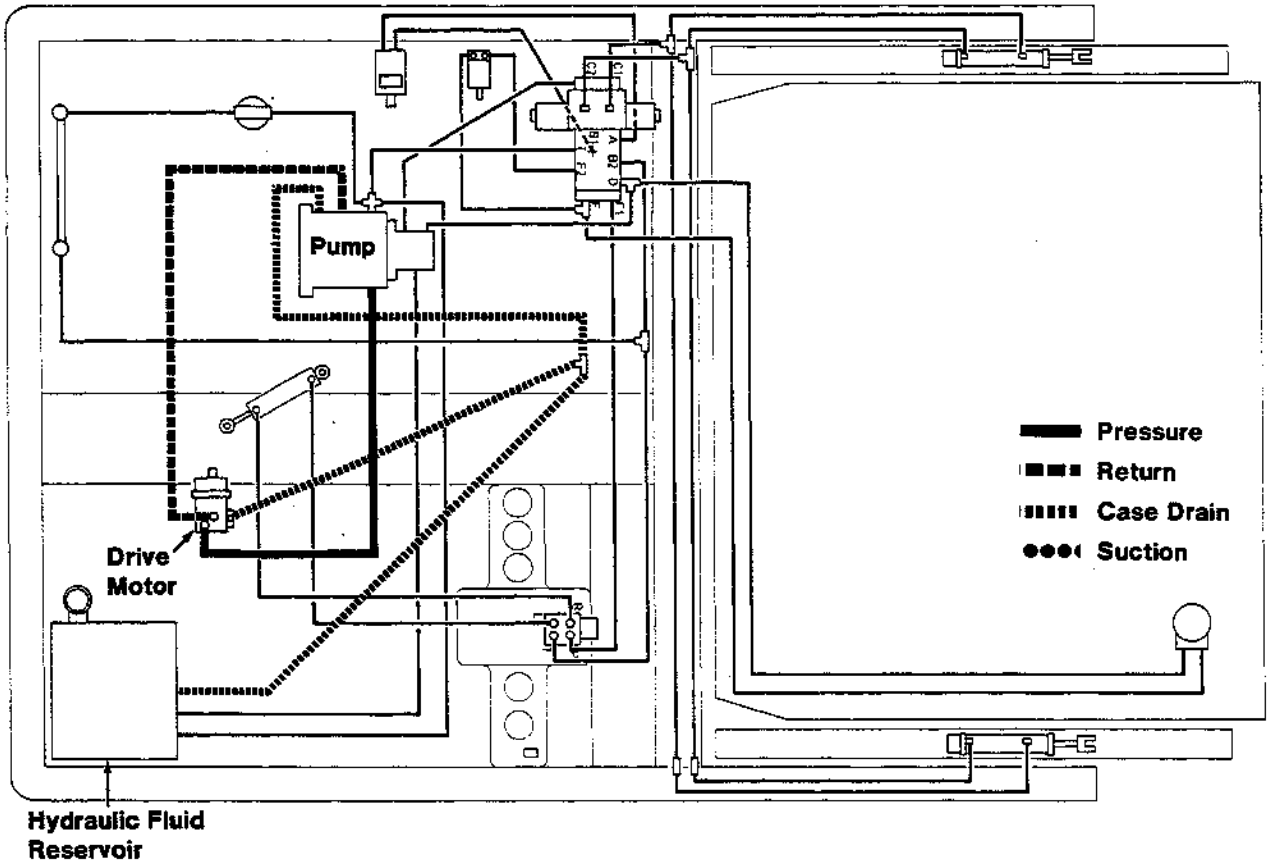
Motor inlet pressure - 4000 to 4400 psi (27,580 to 30,340 kPa)
Volume @ maximum limited speed - 2 gpm (8 L/min)

CIRCUIT TROUBLESHOOTING

Problem	Cause	Remedy
Machine travels slowly or not at all	Parking brake engaged	Release parking brake
	Control linkage broken or not adjusted properly	Replace and/or adjust linkage
	Relief valve stuck open (leaking)	Clean or replace relief valve - one for forward, one for reverse
	Motor failure	See Hydraulic Components Troubleshooting
	Pump failure	See Hydraulic Components Troubleshooting
	Hydraulic fluid level low	Fill hydraulic fluid reservoir
	Brakes dragging	Adjust brakes



DIRECTIONAL CONTROL PEDAL IN "REVERSE" POSITION 02209



PROPELLING-REVERSE CIRCUIT HYDRAULIC FLOWS 02200

STEERING-RIGHT CIRCUIT

When the steering wheel is turned to the right, the rotary steering valve displaces hydraulic fluid to the rod end of the steering cylinder, retracting the cylinder and turning the rear wheel. Hydraulic fluid displaced from the piston end of the cylinder flows back through the rotary valve, heat exchanger, and filter to the reservoir.

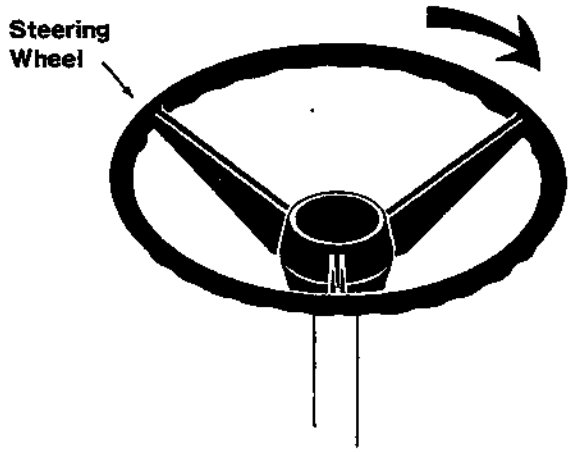
A relief valve is located in the control valve to relieve excess pressure in the steering circuit. Excessive pressure may damage the steering system.

TYPICAL CIRCUIT SPECIFICATIONS

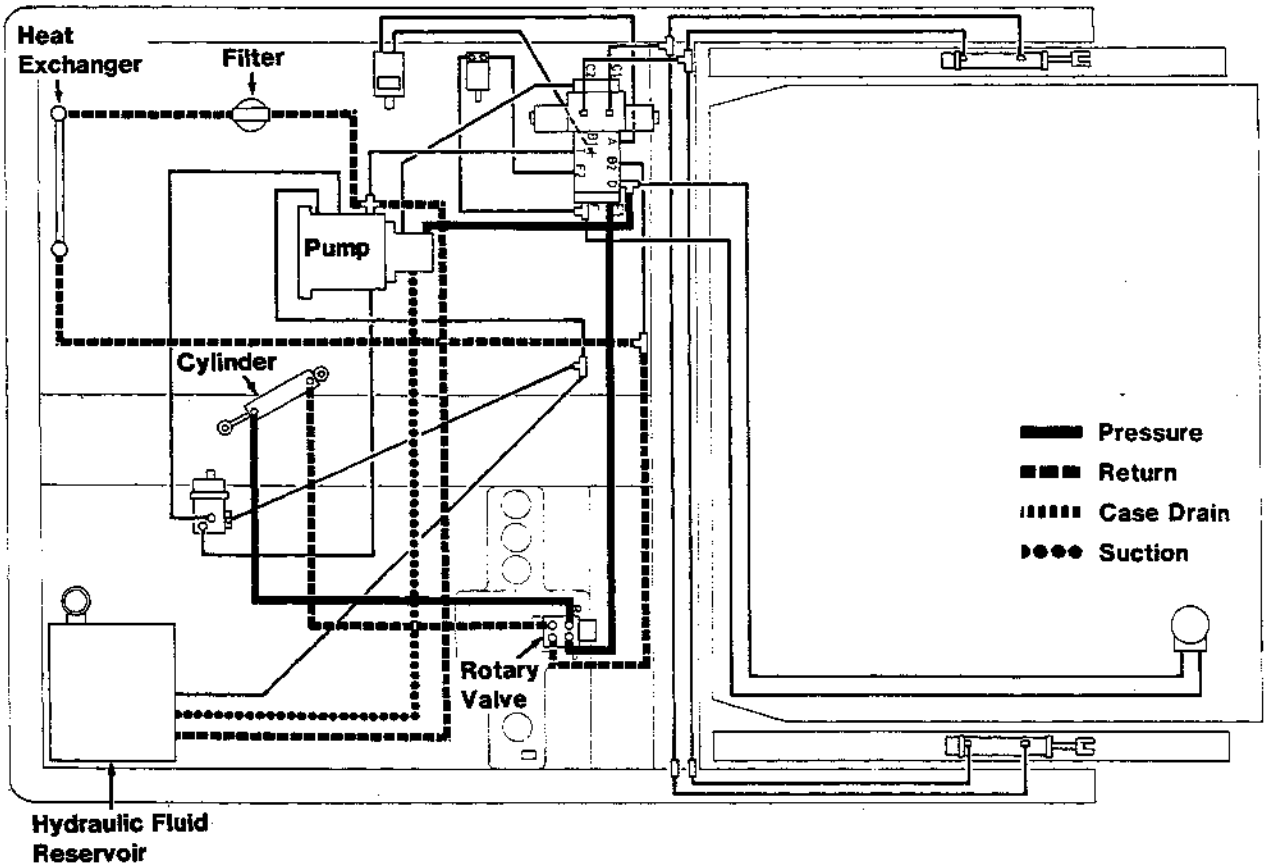
Minimum circuit pressure - 80 to 100 psi (552 to 690 kPa)
Maximum circuit pressure - 500 to 850 psi (3450 to 5860 kPa)

CIRCUIT TROUBLESHOOTING

Problem	Cause	Remedy
Power steering does not work	Relief valve in gear pump or control valve sticking	Clean or replace relief valve
	Steering cylinder failure	See Hydraulic Components Troubleshooting
	Steering valve failure	See Hydraulic Components Troubleshooting
	Gear pump failure	See Hydraulic Components Troubleshooting
	Side brush or Rotary Seal™ motor locked up	Free side brush and/or Rotary Seal™



STEERING WHEEL TURNING RIGHT 02210



STEERING-RIGHT CIRCUIT HYDRAULIC FLOWS 02201

STEERING-LEFT CIRCUIT

When the steering wheel is turned to the left, the rotary steering valve displaces hydraulic fluid to the piston end of the steering cylinder, extending the cylinder and turning the rear wheel. Hydraulic fluid displaced from the rod end of the cylinder flows back through the rotary valve, heat exchanger, and filter to the reservoir.

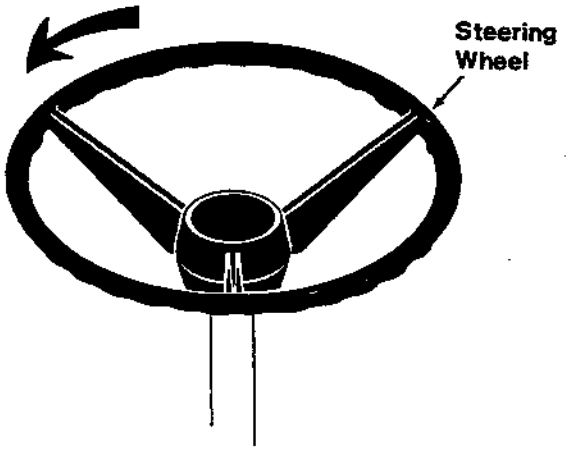
A relief valve is located in the control valve to relieve excess pressure in the steering circuit. Excessive pressure may damage the steering system.

TYPICAL CIRCUIT SPECIFICATIONS

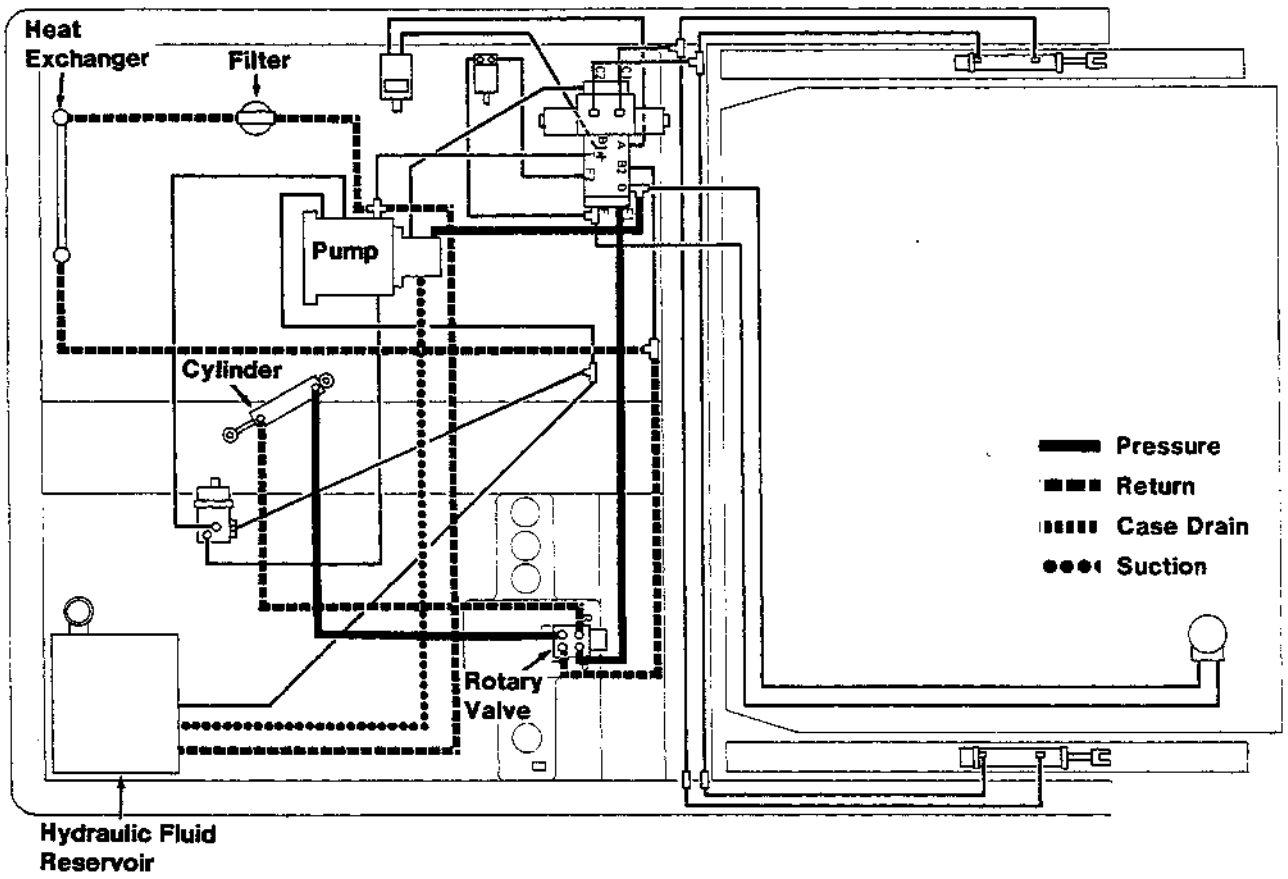
Minimum circuit pressure - 80 to 100 psi (550 to 690 kPa)
Maximum circuit pressure - 500 to 850 psi (3450 to 5860 kPa)

CIRCUIT TROUBLESHOOTING

Problem	Cause	Remedy
Power steering does not work	Relief valve in gear pump or control valve sticking	Clean or replace relief valve
	Steering cylinder failure	See Hydraulic Components Troubleshooting
	Steering valve failure	See Hydraulic Components Troubleshooting
	Gear pump failure	See Hydraulic Components Troubleshooting
	Side brush or Rotary Seal™ motor locked up	Free side brush and/or Rotary Seal™



STEERING WHEEL TURNING LEFT 02210



STEERING-LEFT CIRCUIT HYDRAULIC FLOWS 02202

LIFT CYLINDERS - LIFTING HOPPER CIRCUIT

When the hopper position control switch is pressed into the "up" position, an electrical current flows to the hydraulic solenoid valve SV-5, energizing the solenoid valve. This allows hydraulic fluid to flow through flow restrictors to the piston end of each of the hopper lift cylinders, extending the cylinders, and rolling out and lifting the hopper. Displaced hydraulic fluid from the rod end of the cylinders flows back through the control valve to the reservoir.

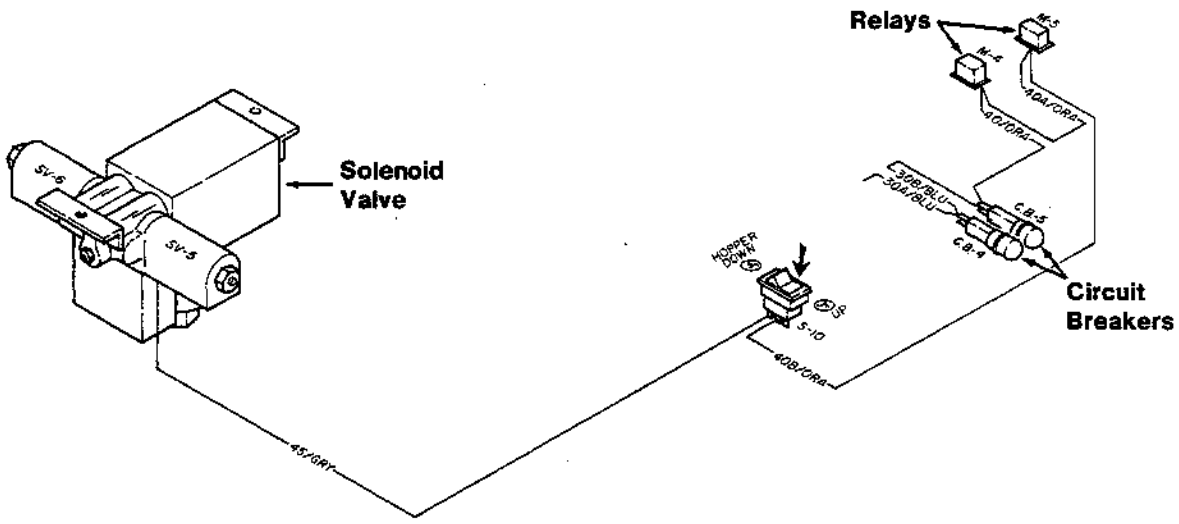
A relief valve is located in the control valve to relieve excess pressure in the lift cylinder circuit.

TYPICAL CIRCUIT SPECIFICATIONS

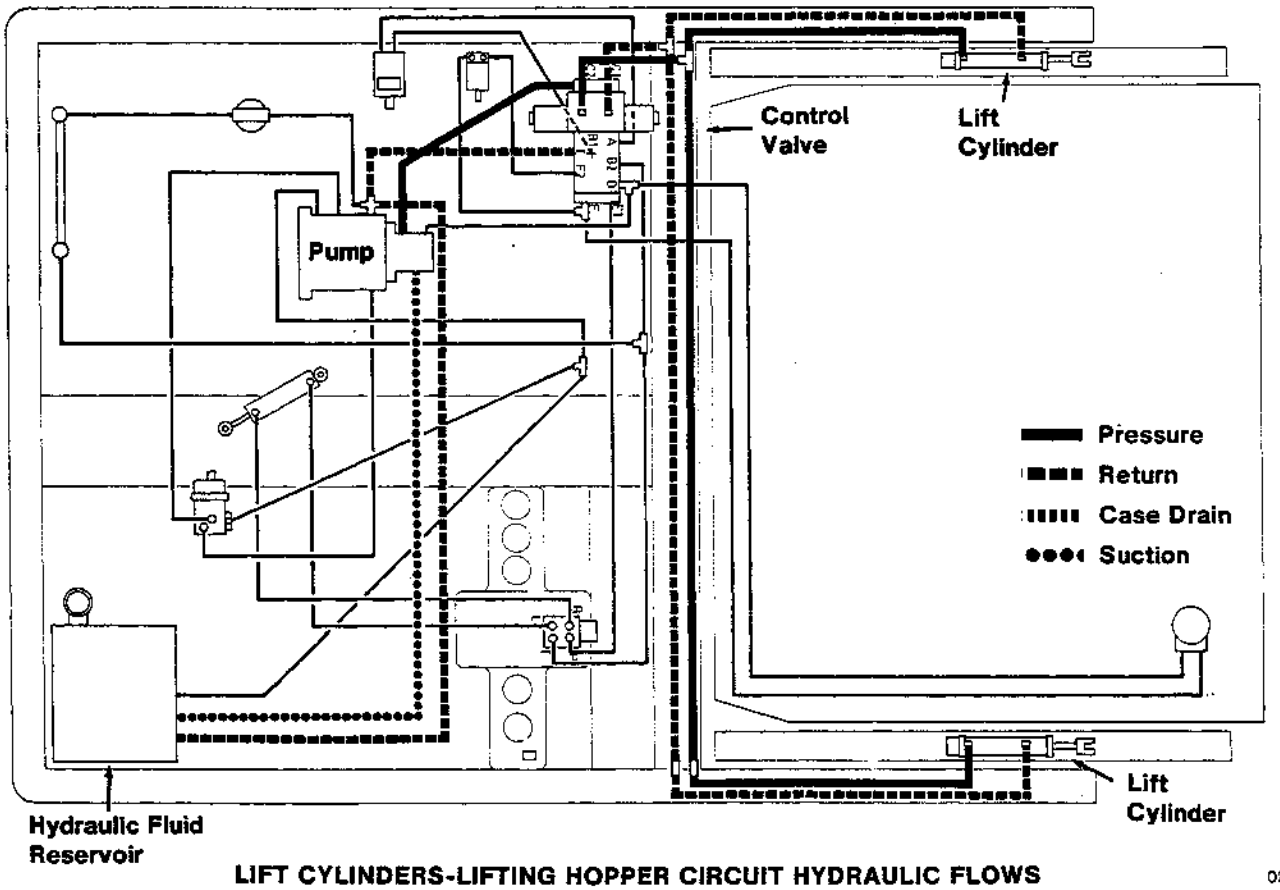
Maximum cylinder inlet pressure - 2100 to 2400 psi (14,480 to 16,550 kPa)
Maximum relief valve pressure - 2000 to 2500 psi (13,790 to 17,240 kPa)
Maximum cycle time - 20 seconds
Maximum solenoid valve current - 3 A @ 12 V

CIRCUIT TROUBLESHOOTING

Problem	Cause	Remedy
Hopper will not lift	Circuit breaker tripped	Reset circuit breaker
	Electric switch S-10 failure	Replace switch
	Hydraulic control valve failure	See Hydraulic Components Troubleshooting
	Hydraulic oriface at lift cylinder plugged	Replace oriface
	Lift cylinder failure	See Hydraulic Components Troubleshooting
	Gear pump failure	See Hydraulic Components Troubleshooting
	Hopper overloaded	Empty hopper
	Lift arms binding	Replace and/or adjust lift arm linkage



HOPPER POSITION CONTROL SWITCH IN "UP" POSITION 02211



LIFT CYLINDERS-LIFTING HOPPER CIRCUIT HYDRAULIC FLOWS 02203

LIFT CYLINDERS-LOWERING HOPPER CIRCUIT

When the hopper position control switch is pressed into the "down" position, an electrical current flows to the solenoid valve SV-6, energizing the solenoid valve. This allows hydraulic fluid to flow to the rod end of each of the hopper lift cylinders, retracting the cylinders, and lowering and rolling in the hopper. Displaced hydraulic fluid from the piston end of the cylinders flows back through the control valve to the reservoir.

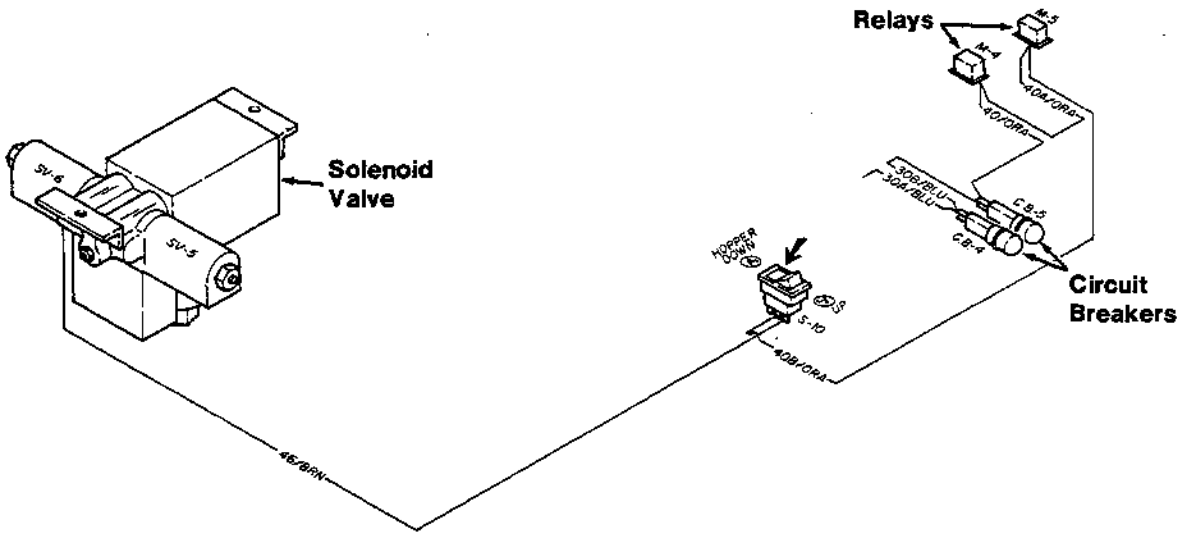
A relief valve is located in the control valve to relieve excess pressure and limit down force when lowering hopper.

TYPICAL CIRCUIT SPECIFICATIONS

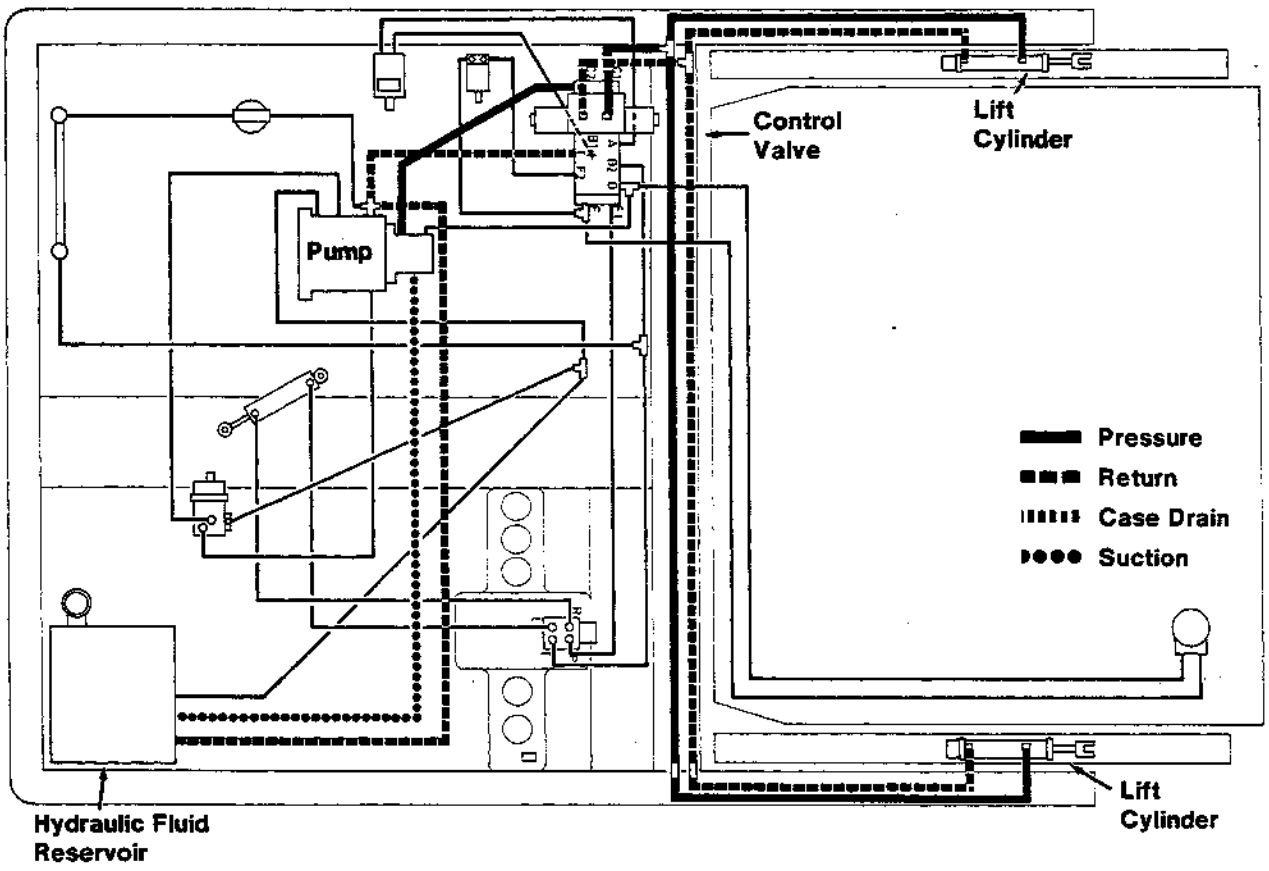
Maximum cylinder inlet pressure - 2100 to 2400 psi (14,480 to 16,550 kPa)
Relief valve pressure - 500 to 800 psi (3450 to 5860 kPa)
Maximum cycle time - 20 seconds
Maximum solenoid valve current - 3 A @ 12 V

CIRCUIT TROUBLESHOOTING

Problem	Cause	Remedy
Hopper will not lower	Circuit breaker tripped	Reset circuit breaker
	Electric switch S-10 failure	Replace switch
	Hydraulic control valve failure	See Hydraulic Components Troubleshooting
	Lift cylinder failure	See Hydraulic Components Troubleshooting
	Gear pump failure	See Hydraulic Components Troubleshooting
	Lift arms binding	Replace and/or adjust lift arm linkage



HOPPER POSITION CONTROL SWITCH IN "DOWN" POSITION 02212



LIFT CYLINDERS-LOWERING HOPPER CIRCUIT HYDRAULIC FLOWS 02204

MAIN BRUSH CIRCUIT

When the main brush control lever is moved into the "normal" or "free float" position, normally closed switch S-8 allows an electrical current to flow to relay M-4 which in turn allows an electrical current to flow to hydraulic solenoid valves SV-2 and SV-3. SV-3 is the Rotary Seal™ solenoid valve—see Rotary Seal™ Circuit. The current to SV-2 energizes and closes it, forcing hydraulic fluid to flow through the main brush motor, driving the main brush. From the main brush motor, the hydraulic fluid flows through the control valve, heat exchanger, and filter to the reservoir.

A relief valve is located in the control valve to relieve excess pressure in the main brush circuit.

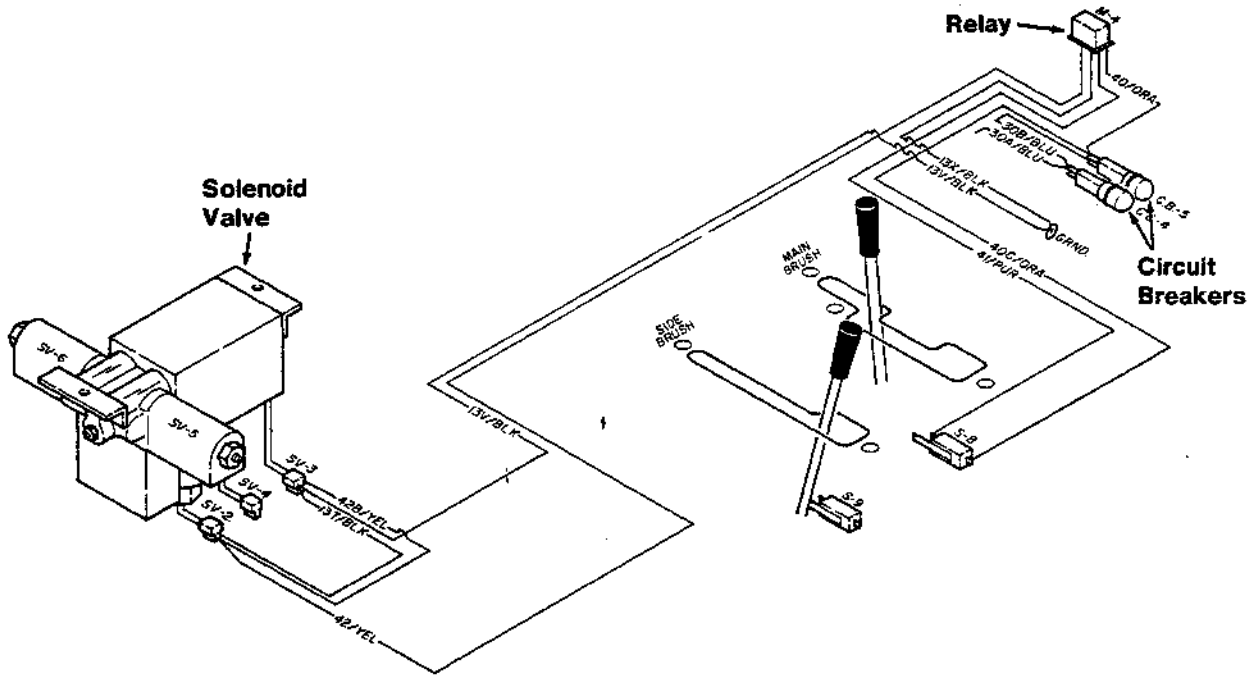
TYPICAL CIRCUIT SPECIFICATIONS

Normal motor inlet pressure - 400 to 1800 psi (2760 to 12,410 kPa), depending on main brush setting, floor surface, or main brush material.

Normal circuit volume - 5.5 to 6.5 gpm (21 to 25 L/min)
Relief valve pressure - 2000 to 2500 psi (13,790 to 17,240 kPa)
Circuit volume near relief pressure - 3 to 4 gpm (11 to 15 L/min)
Maximum solenoid valve current - 2.25 A @ 12 V

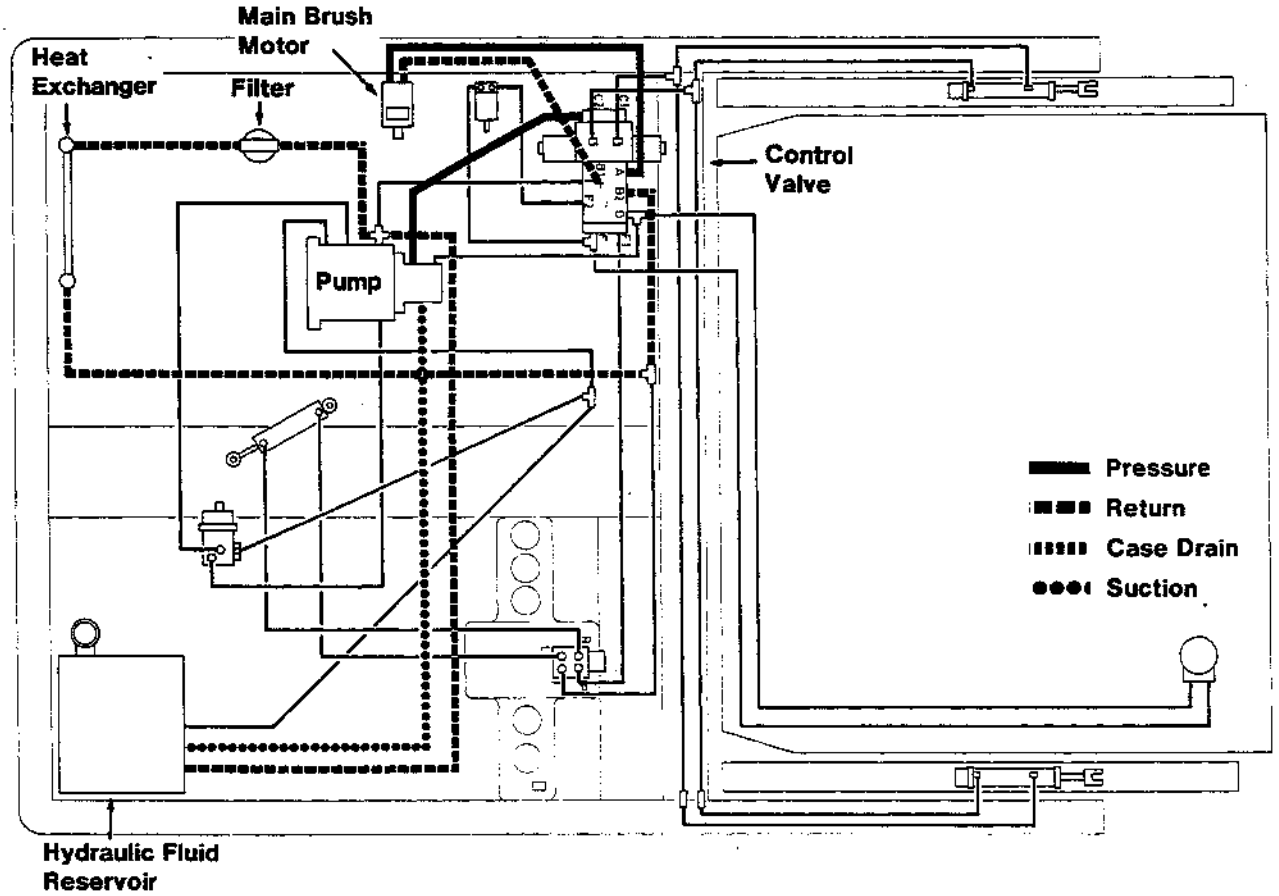
CIRCUIT TROUBLESHOOTING

Problem	Cause	Remedy
Main brush turns slowly or not at all	Debris caught in drive mechanism	Free mechanism of debris
	Circuit breaker tripped	Reset circuit breaker
	Electric switch S-10 failure	Replace switch
	Hydraulic control valve failure	See Hydraulic Components Troubleshooting
	Hydraulic motor failure	See Hydraulic Components Troubleshooting
	Gear pump failure	See Hydraulic Components Troubleshooting



MAIN BRUSH CONTROL LEVER IN "NORMAL" OR "FREE-FLOAT POSITION

02213



MAIN BRUSH CIRCUIT HYDRAULIC FLOWS

02205

ROTARY SEAL™ CIRCUIT

When the main brush control lever is moved into the "normal" or "free float" position, normally closed switch S-8 allows an electrical current to flow to relay M-4 which in turn allows an electrical current to flow to hydraulic solenoid valves SV-2 and SV-3. SV-2 is the main brush solenoid valve—see Main Brush Circuit. The current to SV-3 energizes and closes it, forcing hydraulic fluid to flow through the Rotary Seal™ motor, driving the Rotary Seal™ assembly. From the Rotary Seal™ motor, the hydraulic fluid flows through the control valve, steering rotary valve, heat exchanger, and filter to the reservoir.

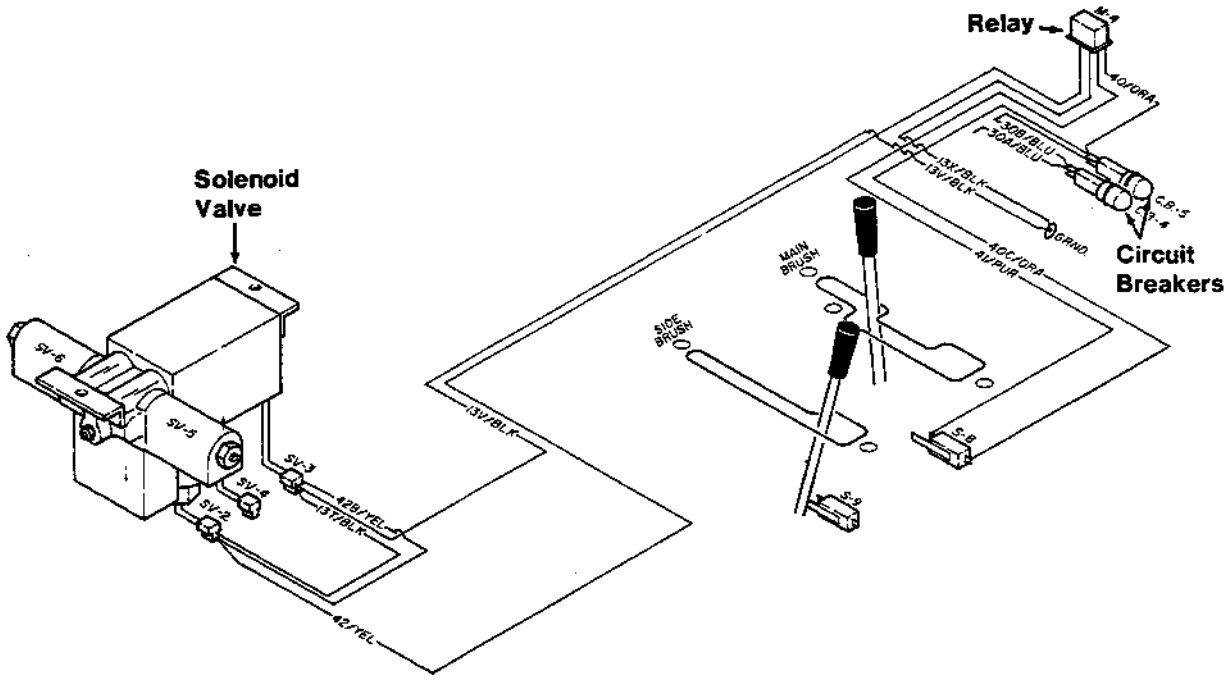
A relief valve is located in the accessory pump to relieve excess pressure in the Rotary Seal™ circuit.

TYPICAL CIRCUIT SPECIFICATIONS

Normal motor inlet pressure - 200 psi (1380 kPa)
Relief valve pressure - 1800 to 2000 psi (12,410 to 13,790 kPa)
Normal circuit volume - 2.3 to 2.7 gpm (9 to 10 L/min)
Maximum solenoid valve current - 1.5 A @ 12 V

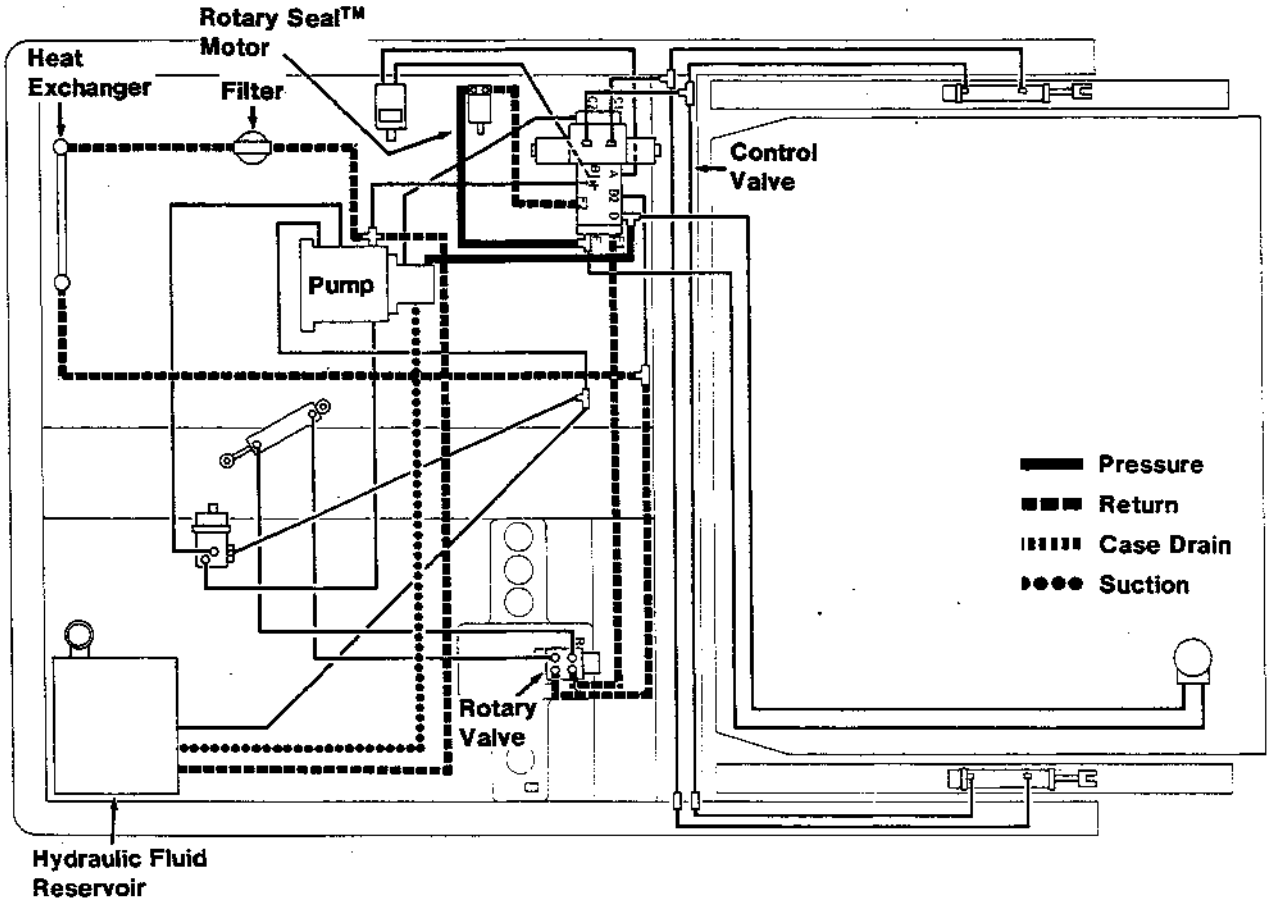
CIRCUIT TROUBLESHOOTING

Problem	Cause	Remedy
Rotary Seal™ turns slowly or not at all	Debris caught in side brush or Rotary Seal™ drive mechanism	Free mechanism of debris
	Circuit breaker tripped	Reset circuit breaker
	Electric switch S-8 failure	Replace switch
	Hydraulic control valve failure	See Hydraulic Components Troubleshooting
	Hydraulic motor failure	See Hydraulic Components Troubleshooting
	Relief valve in gear pump sticking	Clean or replace relief valve
	Main brush control lever in "up-off" position	Place main brush control lever in "normal" or "free-float" position
	Gear pump failure	See Hydraulic Components Troubleshooting



MAIN BRUSH CONTROL LEVER IN "NORMAL" OR "FREE-FLOAT" POSITION

02213



ROTARY SEAL™ CIRCUIT HYDRAULIC FLOWS

02206

SIDE BRUSH AND ROTARY SEAL™ CIRCUIT

When the side brush control lever is placed in the "down" position with the main brush control lever in the "normal" or "free float" position, normally closed switch S-8 allows an electrical current to flow to relay M-4 which in turn allows an electrical current to flow to switch S-9 and hydraulic solenoid valves SV-2 and SV-3. SV-2 is the main brush solenoid valve—see Main Brush Circuit. From switch S-9 an electrical current flows to solenoid valve SV-4. The electrical currents going to solenoid valves SV-3 and SV-4 energizes and closes them, forcing hydraulic fluid to flow through the side brush motor, driving the side brush, and then through the Rotary Seal™ motor, driving the Rotary Seal™ assembly. From the Rotary Seal™ motor, the hydraulic fluid flows though the control valve, steering rotary valve, heat exchanger, and filter to the reservoir.

A relief valve is located in the accessory pump to relieve excess pressure in the side brush and Rotary Seal™ circuit.

TYPICAL CIRCUIT SPECIFICATIONS

Normal side brush motor inlet pressure - 250 to 350 psi (1730 to 2410 kPa)

Normal Rotary Seal™ motor inlet pressure - 200 psi (1380 kPa)

Relief valve pressure - 1800 to 2000 psi (12,410 to 13,790 kPa)

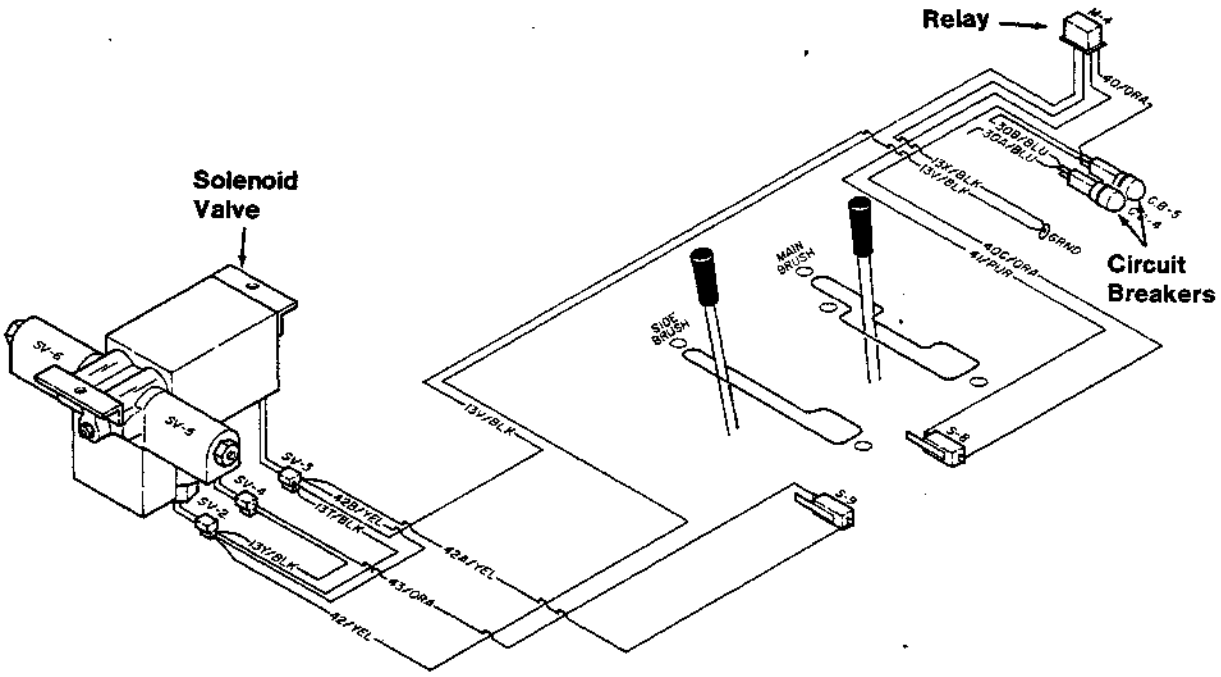
Normal circuit volume - 2.3 to 2.7 gpm (9 to 10 L/min)

Maximum solenoid valve current - 1.5 A @ 12 V

CIRCUIT TROUBLESHOOTING

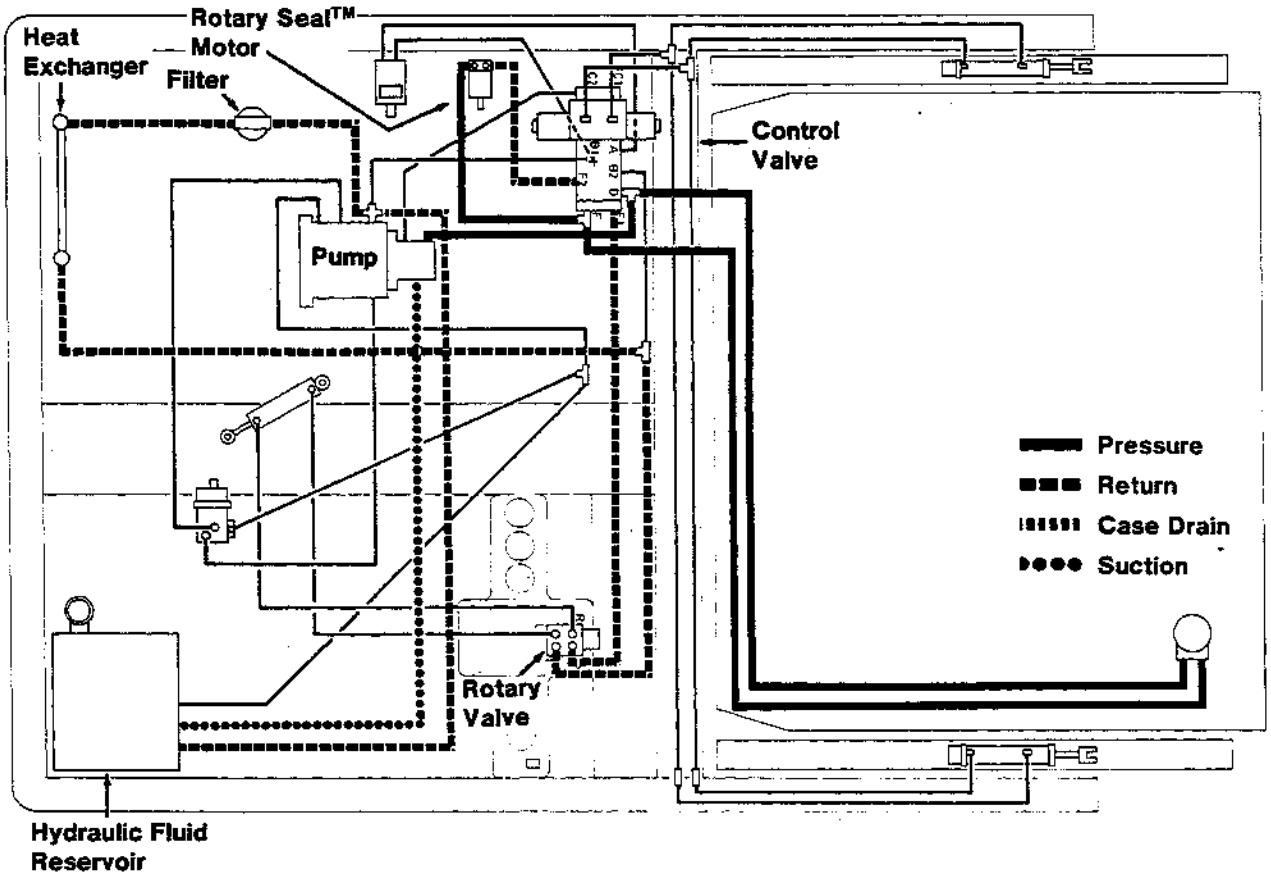
Problem	Cause	Remedy
Side brush turns slowly or not at all	Debris caught in side brush or Rotary Seal™ drive mechanism	Free mechanism of debris
	Circuit breaker tripped	Reset circuit breaker
	Electric switch S-8, S-9 failure	Replace switch
	Hydraulic control valve failure	See Hydraulic Components Troubleshooting
	Hydraulic motor failure	See Hydraulic Components Troubleshooting
	Relief valve in gear pump sticking	Clean or replace relief valve
	Main brush control lever in "up-off" position	Place main brush control lever in "normal" or "free- float" position
	Gear pump failure	See Hydraulic Components Troubleshooting

NOTE: Also see Rotary Seal™ Circuit.



MAIN BRUSH CONTROL LEVER IN "NORMAL" OR "FREE-FLOAT" POSITION AND SIDE BRUSH CONTROL LEVER IN "DOWN" POSITION

02215



SIDE BRUSH AND ROTARY SEAL™ CIRCUIT HYDRAULIC FLOWS

02207

HYDRAULIC COMPONENTS TROUBLESHOOTING

Problem	Cause	Remedy
Hydraulic cylinder failure	Piston seals leaking	Install seal kit
	Barrel worn or rod bent	Replace cylinder
Hydraulic control valve failure	Valve seals leaking	Install seal kit
	Solenoid failure	Replace solenoid
	Solenoid spool sticking	Replace valve section
	Check valve sticking	Replace valve
	Relief valve stuck open (leaking)	Clean or replace relief valve
NOTE: A manual override has been provided on SV-5 and SV-6, which controls hopper lifting and lowering. To override a failed SV-5, which lifts the hopper, push the button on the end of the valve spool opposite the operator. To override a failed SV-6, which lowers the hopper, push the button on the end of the valve spool near the operator.		
Hydraulic steering valve failure	Valve leaking	Install seal kit
	Drive link failure	Replace drive link
	Thrust bearing worn	Replace thrust bearing
	Gerotor worn	Replace gerotor set
Hydraulic motor failure	Motor leaking	Install seal kit
	Drive link failure	Replace drive link
	Gerotor worn	Replace gerotor set
	Output shaft failure	Replace output shaft and bearings
Hydraulic gear pump pump failure	Pump leaking	Install seal kit
	Gear set failure	Replace gear set
	Relief valve stuck	Replace back plate assembly
	Flow divider failure	Replace back plate assembly
	Engine-to-pump coupling failure	Replace coupling

Problem	Cause	Remedy
Hydraulic piston pump failure	Pump leaking	Install seal kit
	Relief valve stuck	Clean or replace relief valve
	Integral charge pump failure	Replace charge pump
	Rotating group worn	Replace rotating group
	Shaft failure	Replace shaft
	Backplate worn	Replace backplate
	Engine-to-pump coupling failure	Replace coupling

ENGINE LUBRICATION

Check the engine oil level daily. Change the engine oil and oil filter after every 50 hours of operation. Use only SAE-SE rated engine oil.

The following SAE-SE rated oil grades are recommended for engines during changing seasonal temperatures:

MULTI-VISCOSITY OILS

Below 32°F (Below 0°C)	-10° to 90°F (-23° to 32°C)	-10° to above 90°F (-23 to above 32°C)	Above 10°F (Above -12°C)
5W 30	10W 30	10W 40	20W 40

SINGLE VISCOSITY OILS

-10° to 32°F (-23° to 0°C)	10° to 60°F (-12° to 16°C)	32° to 90°F (0° to 32°C)	Above 60°F (Above 16°C)
10W	20W 20	30	40

The engine oil capacity is 3.5 qt (3.3 L) including the oil filter. Add three drops of oil to the distributor shaft oil wick after every 100 hours of operation.

COOLING SYSTEM

Maintaining cooling system efficiency is important. Engine temperatures must be brought up to and maintained within the satisfactory range for efficient operation. However, the engine must be kept from overheating in order to prevent damage to the valves, pistons, and bearings. Check the radiator coolant level after every 100 hours of operation.

Use soft, clean water mixed with permanent-type, ethylene glycol antifreeze in a one-to-one ratio to fill the cooling system. Deposits of sludge, scale, and rust prevent normal heat transfer. Flush the radiator and the cooling system after every 800 hours of operation, using a dependable cleaning compound. Follow the mixing procedure recommended by the compound manufacturer. This is important because of the difference in concentration and composition of the cleaning compounds. After cleaning, flush the system with clean water.

Whenever a cooling system is badly rust-clogged, as indicated by overflow loss or abnormally high operating temperatures, corrective cleaning by reverse flow flushing will most effectively remove the heavy deposits of sludge, rust, and scale. The reverse flow flushing should be performed immediately after draining the cleaning solution. Flush the radiator first, then the engine, to allow the engine to cool as much as possible.

Engine overheating may also be caused by dirty radiator fins. The exterior fins of the radiator can be cleaned with an air hose. Clean the radiator exterior after every 100 hours of operation or sooner if operating in a dusty environment.

Blow all dust, which may have collected on the radiator, in through the grill and radiator fins, opposite the direction of normal air flow. Later machines have a tilt-out hydraulic cooler to aid cleaning. Use care not to bend the cooling fins when cleaning. Clean thoroughly to prevent caking dust.

Clean the radiator and cooler after they have cooled to avoid cracking.

The engine is equipped with a 180° F (82° C) thermostat. Normal engine temperature is 200° F (93° C); temperatures up to 220° F (104° C) are allowable; temperatures over 220° F (104° C) indicate a problem exists.

A pressure cap is used on the radiator to prevent overflow loss of water during normal operation. The spring-loaded valve in the cap closes the outlet to the overflow pipe of the radiator and thus seals the system. Pressure developing within the system raises the boiling point of the coolant and allows higher temperatures without overflow loss from boiling. The pressure valve opens at 7 psi (50 kPa), allowing steam and water to pass out the overflow pipe.

⚠ WARNING: If the coolant is hot or if the engine has been operating, loosen the pressure cap to the first stop and let the pressure out of the cooling system before removing the radiator cap. Hot coolant could scald or cause severe burns. If in doubt, let the coolant cool before releasing pressure in the cooling system.

ATTENTION! Never pour cold water or cold antifreeze into the radiator of an overheated engine. Allow the engine to cool to avoid cracking the cylinder head or block. Keep the engine running while adding water.

AIR INTAKE SYSTEM

The importance of maintaining an air filter cannot be overemphasized. Dirt ingested through improperly installed, improperly serviced, or inadequate air filter elements wears out more engines than long hours of operation. Even a small amount of dirt will wear out a set of piston rings in just a few hours. Operating with a clogged air filter element also causes the fuel mixture to be richer, which can lead to formation of harmful sludge deposits in the engine. Always cover the air intake when the air filter is removed for servicing. Do not neglect servicing the air filter. Use only approved replacement parts. Keep all other air intake components secure and in good condition to prevent entrance of unfiltered air.

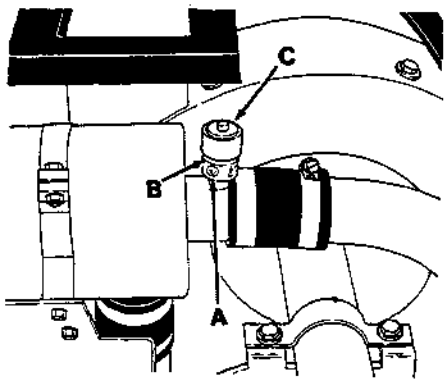
Overmaintenance can cause more damage than good. Removing the air filter element more often than is needed allows contaminants to enter the engine unnecessarily. Clean or replace the air filter element only when the restriction indicator indicates excessive restriction in the system.

POWER SWEEPER - 360 MM146 (10-85) LITHO IN U.S.A.

AIR FILTER RESTRICTION INDICATOR

The air filter restriction indicator signals when to clean or replace the air filter element. Check the restriction indicator daily. The yellow indicator gradually becomes visible as the air filter element loads with dirt. Do not clean or replace the air filter element until the yellow indicator reaches the top of the service indicator and reads 20 in (500 mm). The indicator may return to the "no restriction" position when the engine is shut off. It will return to the "visible" position when the engine is started.

Clean or replace the filter element when the yellow indicator reads 20 in (500 mm). After cleaning or replacing the air filter element, reset the service indicator by pushing the "reset" button on the end of the indicator.



AIR FILTER RESTRICTION INDICATOR 02172

A. Restriction Indicator
B. Indicator Window
C. Indicator Reset Button

AIR FILTER

The engine air filter housing includes a dust cap and a dry cartridge-type air filter element. The dust cap must be emptied of dirt daily. The air filter element must be cleaned and inspected or replaced whenever the yellow indicator of the air filter restriction indicator reads 20 in (500 mm). The filter element must be replaced if it is damaged or has been cleaned three times.

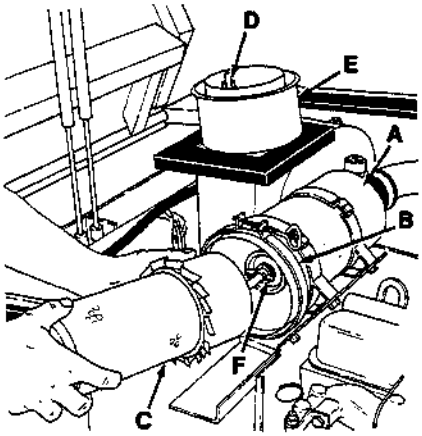
Service the air filter element only when the restriction indicator indicates excessive restriction in the system. Do not remove the air filter element unless it is restricting air flow.

TO REPLACE AIR FILTER ELEMENT

1. Stop the engine and engage the machine parking brake.

⚠ WARNING: Always park on a level surface, stop the engine, and engage parking brake before working on the machine to keep it from creeping or rolling.

2. Open the left side and top engine access doors.
3. Unscrew the clamp ring on the filter.
4. Remove the dust cap.
5. Empty the dust cap.
6. Remove the filter wing nut.
7. Gently pull the filter element out of the filter housing.



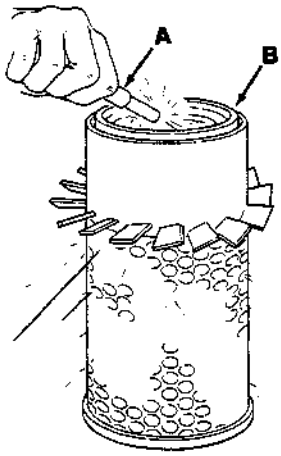
REMOVING AIR FILTER ELEMENT 02173

A. Filter Housing
B. Clamp Ring
C. Filter Element
D. Wing Nut
E. Dust Cap
F. Safety Air Filter Element

NOTE: Machines with heavy-duty air cleaner accessory have a safety filter element. The safety filter element should be replaced, not cleaned, after the regular element has been damaged or has been serviced three times.

8. Clean the interior of the air cleaner housing with a damp cloth. Clean the element housing sealing surfaces.
9. Using an air hose, direct dry, clean air maximum 30 psi (205 kPa) up and down pleats on the inside of the filter. Do not rap, tap, or pound dust out of the element.

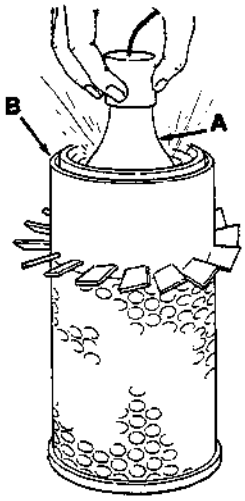
⚠ WARNING: Wear approved eye protection when using air hoses to prevent eye injury.



CLEANING AIR FILTER ELEMENT 00051

A. Air Hose
B. Filter Element

10. After cleaning the air filter element, inspect it for damage by placing a bright light inside. The slightest rupture requires replacement of the filter. Clean and inspect the seals on the ends of the element. They should be unbroken and flexible. Remember, the element must be replaced after it has been cleaned three times.

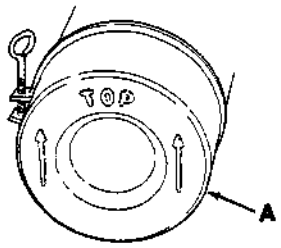


INSPECTING AIR FILTER ELEMENT 00051

A. Bright Light
B. Filter Element

11. Install the new or cleaned filter element so the fins on the element are at the intake end of the air cleaner. Use care so the fins are not damaged. Make sure the element is seating evenly. Tighten the element wing nut.

12. Install the dust cap with the arrows pointing up. Tighten the clamp ring to hold it in place. Check all intake hose connections for leaks or abrasion.



DUST CAP 02492

A. Dust Cap

13. Reset the air filter restriction indicator.

14. Close the access doors.

FUEL SYSTEM - GASOLINE

FUEL FILTER

The fuel filter traps fuel impurities. It is located below the air filter. Replace the filter element after the first 50 hours of operation and then as required.

CARBURETOR

The carburetor has two basic adjustments. Those adjustments are idle fuel mixture and idle speed. Check and adjust idle fuel mixture and idle speed after every 400 hours of operation. The idle fuel mixture is controlled by a screw located on the front of the carburetor. Turning the screw in, clockwise, leans the fuel mixture. Turning the screw counterclockwise, richens the fuel mixture.

⚠ WARNING: Always wear eye protection and stay clear of engine fan and drive belts when working in the engine compartment with the engine operating to avoid severe personal injury.

The idle speed is controlled by a screw located on the side of the carburetor next to the throttle linkage. Turning the screw clockwise increases engine speed. Turning the screw out, counterclockwise, decreases engine speed. Proper idle speed is 950 ± 50 rpm with all accessories in the "off" position.

⚠ WARNING: No smoking or open flame should be allowed when the fuel system is being repaired or serviced. The area should be properly ventilated. Improper handling of fuel or fuel fumes could result in an explosion or fire.

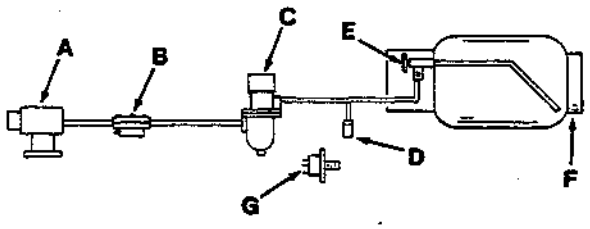
FUEL SYSTEM - LPG

LPG FUEL SYSTEM

The liquid withdrawal LPG fuel system is made up of five components which are: the LPG fuel tank, pressure relief valve, fuel filter lock, vaporizer-regulator, and the carburetor.

Liquid LPG fuel flows from the LPG tank, under its own pressure, to the pressure relief valve. This valve is normally closed, preventing LPG fuel from escaping into the atmosphere. The valve opens to relieve pressure if the fuel pressure exceeds system limits. From the pressure relief valve, the liquid LPG fuel is piped to the fuel filter lock. The fuel filter lock filters unwanted tank scale and deposits out of the LPG fuel. The fuel filter lock also stops the flow of LPG fuel when the engine is not operating. The oil pressure switch controls the fuel filter lock. When the engine oil pressure is 4 psi (30 kPa) or greater, the oil pressure switch permits an electrical current to open the fuel filter lock which allows LPG fuel to flow on to the vaporizer-regulator. The oil pressure switch is bypassed when the engine is being started, allowing LPG fuel to flow.

The vaporizer section of the vaporizer-regulator converts the liquid LPG fuel into a gaseous LPG fuel. From the vaporizer section, the gaseous LPG fuel is sent to the primary regulator section of the vaporizer-regulator. The primary regulator section reduces the pressure of the LPG fuel. The secondary regulator section reduces the LPG fuel pressure to the level required by the carburetor. From the vaporizer-regulator, the LPG fuel is sent to the carburetor where it is finally metered into the air flow which is sent to the engine combustion chamber.



LPG FUEL SYSTEM 00582

A. Carburetor
B. Vaporizer-Regulator
C. Fuel Filter Lock
D. Pressure Relief Valve
E. Tank Service Valve
F. LPG Fuel Tank
G. Oil Pressure Switch

Never operate an LPG powered machine if the LPG fuel system is leaking, or if any component in the fuel system is malfunctioning. Operating the machine under either of these conditions may cause a fire or explosion.

Check for frosting. If frosting occurs on or near any LPG component, there is a possibility of an LPG fuel leak or a malfunctioning component. To locate the leak, apply a soapy water solution to the suspected area. Watch for bubbles forming in a confined area. This area may have an LPG fuel leak. Repair or replace the part. Use Loctite brand Stainless Steel PST thread sealant when reassembling. This epoxy-type sealant is not affected by aging or high humidity. Be sure to follow application directions and apply proper torque when reconnecting fittings. Never bypass safety components except to test. If they are defective, replace them before operating the machine.

Check routings of all LPG hoses. Keep them away from sharp edges, exhaust manifolds, or other hot surfaces. Check for signs of abrasion or deterioration. Replace hoses found to be worn or damaged.

FUEL TANKS

The LPG fuel tanks should be inspected for sharp dents, gouges, leaks, and broken protecting rings whenever the tanks are refilled. All tank valves must be inspected for leaks using a soap solution. Valves must also be checked for dirt, paint, or other debris in the valve openings. The following specific checks must also be made:

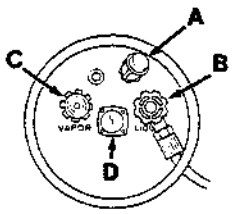
Filler Valve - Check for proper functioning and the presence of the handwheel. Valve must be closed except during filling.

Vapor and Liquid Service Valves - Check for proper functioning and presence of the handwheel. The valve must be closed except when in service.

Tank Service Valve Coupling - Check for proper functioning, thread condition, and damaged or missing washers or o-rings.

Safety Relief Valve - Check for damage. Check for the presence of the relief valve elbow and the proper direction of the elbow. If the rain cap is missing, check for foreign matter and replace cap. Do not tamper with the relief valve setting.

Magnetic Liquid Level Gauge - Check operation against the maximum filling point as determined by weight.



00115

TYPICAL LPG LIQUID WITHDRAWAL FUEL TANK

A. Filler Valve
B. Safety Relief Valve
C. Liquid Service Valve
D. Liquid Level Gauge

An LPG fuel tank with any of the stated defects must be removed from service and be repaired or destroyed accordingly.

If an LPG fuel tank is damaged or leaking, it should be removed to a designated safe area, and the proper personnel should be notified. Do not attempt to make repairs to the tank, regardless of condition. Repairs or disposal must only be made by qualified personnel.

The care an LPG fuel tank receives has a direct bearing on how long that tank can be used safely. LPG fuel tanks must not be dropped or dragged across any surface. To move LPG fuel tanks, use a hand truck or roll the tank on its foot ring while it is being held in a position slightly off vertical.

Whether the storage is inside or outside, fuel tanks should not be stored in the vicinity of combustible materials or high temperature sources such as ovens and furnaces, since the heat may raise the pressure of the fuel to a point where the safety relief valves would function. Care should be taken to insure that the tanks are stored in such a manner that if the safety relief valves do function, they will relieve vapor, rather than liquid.

Valves on empty tanks must be closed during storage and transportation.

Similar precautions should be taken in storing machines fitted with LPG fuel tanks. They may be stored or serviced inside buildings, provided there are no leaks in the fuel system and the tanks are not overfilled. While machines are being repaired inside a building, the shut-off valve on the tank must be closed, except when the engine must be operated.

The tank changing operation presents an opportunity for the machine operator to carefully observe the tank, fittings, and the fuel lines and fittings for his own satisfaction. If abnormal wear is detected, the operator should report his findings to his supervisor for appropriate action.

TO CHANGE AN LPG FUEL TANK

1. Park the machine in a designated safe area.

⚠ WARNING: No smoking or open flame should be allowed when the fuel system is being repaired or serviced. The area should be properly ventilated. Improper handling of fuel or fuel fumes could result in an explosion or fire.

2. Close the tank service valve.
3. Operate the engine until it stops from lack of fuel, then engage the machine parking brake.

⚠ WARNING: Always park on a level surface, stop the engine, and engage the parking brake before working on the machine to keep it from creeping or rolling.

4. Put on gloves and remove the quick-disconnect tank coupling.

⚠ CAUTION: Always wear gloves when disconnecting the tank coupling to prevent escaping LPG fuel from freezing hands.

5. Inspect the LPG fuel lines for wear or damage.
6. Remove the empty LPG fuel tank from the machine.
7. Check the tank for damage or wear.
8. Store the tank in a designated safe area.
9. Select a filled LPG fuel tank and inspect it for damage or leaks.

NOTE: Make sure the LPG fuel tank matches the fuel system (liquid tank with liquid system).

10. Carefully place the LPG tank in the machine so that the tank centering pin enters the aligning hole in the tank collar.

NOTE: If the pin cannot be engaged, make sure you have the correct LPG fuel tank and then adjust the pin locator in or out.

11. Fasten the tank hold-down clamp to lock the tank in position.
12. Connect the LPG fuel line to the tank service coupling. Make sure the service coupling is clean and free of damage. Also make sure it matches the machine service coupling.
13. Open the tank service valve slowly and check for leaks.

⚠ WARNING: If an LPG leak is found, close the service valve immediately and notify the appropriate personnel.

14. If no leaks are found, the engine is ready to start.

FUEL FILTER LOCK

The fuel filter lock filters the LPG fuel. It also stops the flow of LPG fuel to the engine when the engine is not operating or when the engine oil pressure is less than 4 psi (30 kPa).

Replace the filter pack with the filter pack replacement kit if diminished gas flow indicates the filter is clogged. A drain plug is provided for purging the filter bowl. Clean out the bowl when replacing the filter pack.

⚠ WARNING: Do not bypass the fuel filter lock unless testing is being done. Reconnect the fuel filter lock when testing is complete. A potential fire hazard may be created if the fuel filter lock is bypassed after testing.

To check the fuel filter lock for proper operation:

Start the engine. Remove the wire going to the solenoid section of the fuel filter lock. This should cause the solenoid to close, shutting off the fuel supply and stopping the engine. If the engine continues to operate, replace the fuel filter lock.

If the engine stopped as it should, allow the machine to stand with the LPG tank valve open and the wire removed from the fuel filter lock. After 10 minutes, operate the starter motor. If the engine starts or fires, LPG fuel has leaked by the fuel filter lock and the fuel filter lock should be replaced. If the engine just turned over, the fuel filter lock is operating correctly.

VAPORIZER-REGULATOR

If any malfunction is noted, completely disassemble the vaporizer-regulator. Clean all of the parts in alcohol. Inspect all of the parts and replace where needed. Carefully reassemble the vaporizer-regulator with the seal repair kit.

After reinstalling vaporizer-regulator in machine, perform the following checks: Turn on the ignition switch, short out the oil pressure switch leads, open the radiator cap, and check the coolant for bubbles. If bubbles are present, the vaporizer may have a leaking gasket or may have developed a pinhole leak, allowing LPG fuel to enter the cooling system.

Check for proper operation. Use a pressure gauge to check the output of the regulator to make sure it is working per specifications.

CARBURETOR

If any malfunction is noted, completely disassemble the carburetor. Clean all of the parts in alcohol.

Inspect all of the parts and replace when needed. Carefully reassemble the carburetor with the seal repair kit.

OIL PRESSURE SWITCH

The engine oil pressure switch requires no regular maintenance. Never bypass the oil pressure switch as this is a safety feature which prevents LPG fuel from flowing when the engine is not operating properly.

⚠ WARNING: Never bypass the oil pressure switch unless testing of other components is being done. Reconnect the switch when testing is complete. A fire hazard may be created if the oil pressure switch is bypassed after testing.

To check the oil pressure switch:

Turn the ignition switch to the "on" position. If a click in the fuel filter lock is heard, the oil pressure switch is not operating properly. If no click is heard, remove the wire from the "c" terminal and touch it to the "no" terminal. This shorts the switch out. The fuel filter lock should click when the switch is shorted out if the switch is working properly.

LPG FUEL TROUBLESHOOTING

Problem	Cause	Remedy
Engine will not start	Out of fuel	Replace fuel tank with full one
	Service valve opened too quickly - engaging safety valve	Close valve and reopen slowly
	Plugged fuel filter	Replace filter
	Kinked or restricted fuel line	Straighten or replace fuel line
	Engine out of tune	Tune-up engine
	Oil pressure switch failure	Replace oil pressure switch
	Fuel lock valve failure	Repair or replace fuel filter lock
	Vaporizer-regulator failure	Repair or replace vaporize - regulator
Engine runs unevenly or lacks power	Wrong type of fuel tank - vapor withdrawal tank	Replace vapor withdrawal tank with liquid withdrawal tank
	Plugged fuel filter	Replace filter
	Kinked or restricted fuel line	Straighten or replace fuel line
	Engine out of tune	Tune-up engine
	Restricted air filter	Clean or replace air filter element
	Vaporizer - regulator maladjusted	Adjust vaporizer - regulator

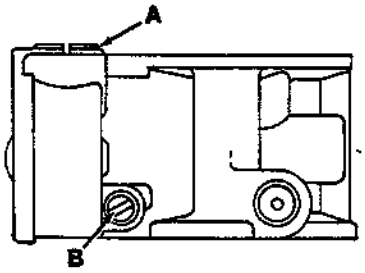
GOVERNOR

The engine speed is governed by a velocity governor located under the engine carburetor. The governor makes the engine operate at a constant speed. It is factory set and should not be adjusted unless the engine exceeds 2400 ± 50 rpm under load, 2700 ± 100 rpm no-load, or if the engine surges.

TO ADJUST GOVERNOR

To adjust the governor, first remove the lock wire. For higher speed, turn main adjusting screw clockwise; for slower speed, counterclockwise. Always turn governor up to desired speed setting. If setting is too fast, turn back to below the desired setting, then up to it. When desired speed is reached, install seal.

⚠ WARNING: Always wear eye protection and stay clear of engine fan and drive belts when working in the engine compartment with the engine operating to avoid severe personal injury.



VELOCITY GOVERNOR 01314

A. Main Adjusting Screw
B. Secondary Adjusting Screw

The secondary adjusting screw is factory set to cover a wide range of engine speeds. In setting the governor to desired engine speed, use main adjusting screw only. If governor control is either too sharp or not sharp enough, follow instructions below. Only in rare instances does the secondary adjustment have to be changed.

Drill welch plug covering secondary adjusting screw with a 0.06 in (2 mm) drill. Insert a 0.06 in (2 mm) diameter rod in drilled hole and pry off welch plug.

If governor control is too sharp, causing surging or hunting, turn secondary adjusting screw clockwise one-fourth turn at a time. Turn main adjusting screw counterclockwise approximately one turn for every one-fourth turn of secondary screw to bring speed adjustment back to normal.

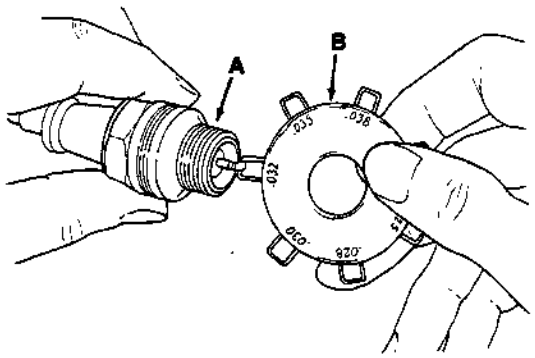
If governor control is not sharp enough, which causes too great a variation in speed between load and no load, turn secondary adjusting screw counterclockwise one-fourth turn at a time. Turn main adjusting screw clockwise approximately one turn for each one-fourth turn of secondary screw to bring the speed back to normal.

ELECTRICAL SYSTEM

SPARK PLUGS

Clean or replace and adjust spark plugs after every 400 hours of operation. Spark plug gaps are best checked with a wire gauge unless the plug is dressed to obtain a correct reading with a flat gauge. The adjustment should always be made on the side electrode and never on the center electrode, which may cause a broken porcelain.

"Gapping" the electrode tip is more easily done with the proper tools.



GAPPING THE SPARK PLUG 01174

A. Spark Plug
B. Gapping Tool

The proper spark plug gap is 0.032 in (0.8 mm).

Spark plugs must be correctly installed in order to obtain good performance. It is a simple but important matter to follow these procedures when installing plugs:

1. Clean the spark plug seat in the cylinder head.
2. Use a new seat gasket and screw the plug in by hand.
3. Tighten the spark plugs to 22 to 28 ft lb (30 to 38 Nm) with a socket wrench of the correct size.

DISTRIBUTOR

The distributor operation is vital to the operation of the engine. The following items should be carefully inspected after every 400 hours of normal operation; however, dirt, dust, water, and high speed operation may cause more rapid wear and necessitate more frequent inspections:

1. Remove the distributor cap. Clean the cap and examine for cracks, carbon runners, or corroded terminals. If the vertical faces of the inserts are burned, install a new cap. If the horizontal faces of the inserts are burned, replace the cap and the rotor as this condition is caused by the rotor being too short.
2. Check the centrifugal advance mechanism for "freeness" by turning the breaker cam in the direction of rotation and then releasing it. The advance springs should return the cam to its original position.
3. Lubricate the shaft felt, advance mechanism, breaker cam, and pivot. Make sure the breaker arm moves freely on its hinge. Special grease with Moly should be used sparingly on the breaker cam.

NOTE: Avoid excessive lubrication. Excess lubricant may get on the contact points and cause burning.

4. Clean and check or replace the ignition points and gap. If the points are pitted, burned, or worn to an unserviceable condition, install a new set of points. Badly pitted points may be caused by a defective or improper condenser capacity.

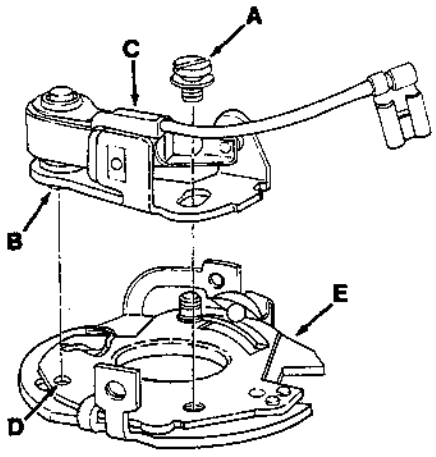
   If the points are serviceable, they should be dressed down with a fine cut stone or point file. The file must be clean and sharp; never use emery cloth to clean contact points.

   After filing, check the point gap and reset to 0.025 in (0.6 mm), 48° to 52° dwell. The breaker arm must be resting on the high point of the cam during this operation.

   When replacing points, make sure they are aligned and make full contact. Bend the stationary arm to obtain proper alignment; do not bend the breaker arm.

TO REPLACE IGNITION POINTS

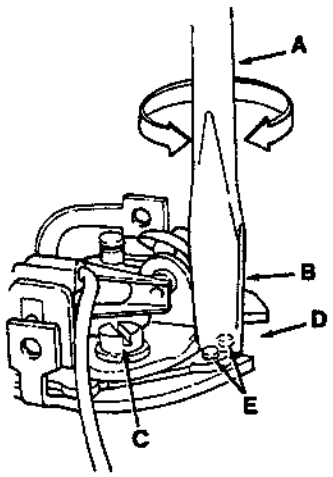
1. Remove the distributor cap and the rotor.
2. Disconnect the condenser wire from the ignition point assembly.



INSTALLING IGNITION POINTS 00694

A. Retaining Lockscrew
B. Pin
C. Ignition Point Assembly
D. Hole
E. Advance Plate

3. Remove the ignition points attaching screw and lift out the ignition point assembly.
4. Remove the condenser by removing the screw attaching the condenser to the distributor plate.
5. Install the new condenser.
6. Position the new ignition points on the advance plate and install the attaching screw.
7. Connect the condenser wire to the ignition points.
8. Adjust the ignition points to 0.025 in (0.6 mm). The dwell angle is 48° to 52°.



ADJUSTING IGNITION POINTS 00695

A. Screwdriver
B. Screwdriver Blade
C. Lockscrew
D. Slot
E. Boss

DISTRIBUTOR IGNITION TIMING

The distributor ignition timing must be checked with a timing light, using the timing points located on the front of the engine and the timing marks located on the crankshaft pulley. Distributor ignition timing should be checked after the first 50 hours of operation and after every 400 hours of operation thereafter.

To check and adjust the ignition timing with a scope, refer to the scope manufacturer's instructions. To check and adjust the timing with a timing light, proceed as follows:

TO CHECK AND ADJUST DISTRIBUTOR IGNITION TIMING

NOTE: Dwell angle must be correct or timing will not be accurate.

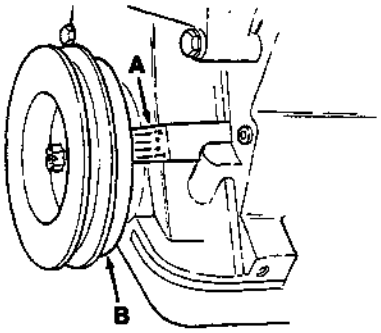
1. Stop the engine and engage the machine parking brake.

⚠ WARNING: Always park on a level surface, stop the engine, and engage the parking brake before working on the machine to keep it from creeping or rolling.

2. Clean and mark the timing marks.

NOTE: Painting a white line on the front pulley timing marks will make them more legible under the timing light.

3. Disconnect and plug the vacuum hose from the distributor.



ENGINE TIMING MARKS 00696

A. Timing Pointer
B. Crankshaft Pulley

⚠ CAUTION: Do not hold ignition wires with bare hands since shocks or other injuries can result.

4. Connect the timing light to the No. 1 cylinder spark plug wire. Connect a tachometer to the engine.

⚠ WARNING: Always wear eye protection and stay clear of engine fan and drive belts when working in the engine compartment with the engine operating to avoid severe personal injury.

5. Start the engine and reduce the idle speed to 600 rpm to be sure that the centrifugal advance is not operating. Adjust the initial ignition timing to 10° to 12° BTDC on gasoline engines, and 12° to 14° BTDC on LPG engines.

   To advance the timing, turn the distributor body clockwise. To retard the timing, turn the distributor body counterclockwise.

6. Check the centrifugal advance for proper operation by starting the engine and accelerating it to approximately 2000 rpm. If the ignition timing advances, the centrifugal advance mechanism is functioning properly. Note the engine speed when the advance begins and the amount of total advance. Stop the engine.

7. Unplug the vacuum line and connect it to the distributor vacuum advance unit. Start the engine and accelerate it to approximately 2000 rpm. Note the engine speed when the advance begins and the total amount of advance. Advance of the ignition timing should begin sooner and advance farther than when checking the centrifugal advance alone. Stop the engine.

8. If the vacuum advance is not functioning properly, remove the distributor and check it on a distributor tester.

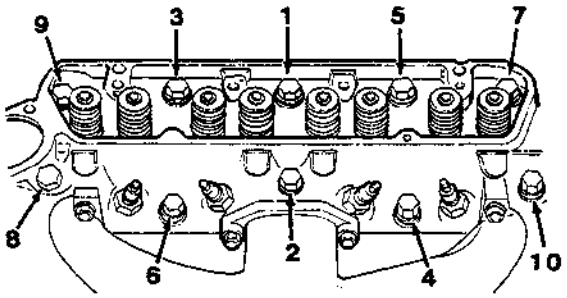
9. After adjusting timing, be sure to increase the engine idle speed to its normal setting.

CYLINDER HEAD

A three-stage torque procedure should be used when reassembling the cylinder head. The cylinder head bolts must be tightened after the first 50 hours of operation and seasonally thereafter.

Snug down cylinder head bolts in the proper sequence; first to 20 to 30 ft lb (27 to 41 Nm), then to 50 to 55 ft lb (68 to 75 Nm), and then to 65 to 70 ft lb (88 to 95 Nm).

Tighten the intake manifold bolts to 15 to 18 ft lb (20 to 24 Nm) after every 800 hours of operation.



00697

CYLINDER HEAD BOLT TIGHTENING SEQUENCE

The cylinder head bolts must be retorqued after the engine is put into operation and brought up to proper operating temperatures. To retorque head bolts, follow the correct sequence. Loosen one head bolt at a time one-quarter turn, 90 degrees; then retorque it to the correct value.

NOTE: Power wrench torque limit must be held at least 10 ft lb (14 Nm) below hand torque specification; then hand torque to the specifications.

VALVE TAPPET CLEARANCE ADJUSTMENT

The valve tappet clearance must be checked and adjusted if necessary after every 400 hours of operation.

To set the valve clearance, rotate the crankshaft until No. 1 cylinder is at the top of the compression stroke. Check the timing marks. It should read 0 or TDC. Both valves on No. 1 cylinder are now closed. Set the valve clearance on both valves. Next, rotate the crankshaft 180°, and set the valve lash on both valves on No. 2 cylinder. Again rotate the crankshaft 180°, and set the valve lash on both valves on No. 4 cylinder. Rotate the crankshaft another 180°, and set the valve lash on both valves on No. 3 cylinder.

Check and adjust the intake valve clearance from 0.008 to 0.010 in (0.20 to 0.25 mm) and the exhaust valve clearance from 0.018 to 0.020 in (0.45 to 0.50 mm) while the engine is cold.

CRANKCASE VENTILATION SYSTEM

Clean the crankcase ventilation hoses, tubes, and fittings and replace the PCV valve after every 400 hours of operation.

TUNE-UP CHART	
Idle speed, no load	750 ± 50 rpm
Maximum governed speed, under load no load	2400 ± 50 rpm 2700 ± 100 rpm
Spark plug gap	0.032 in (0.8 mm)
Ignition point gap	0.025 in (0.6 mm)
Dwell angle	48° to 52°
Timing	10° to 12° BTDC @ 600 rpm, gasoline 12° to 14° BTDC @ 600 rpm, LPG
Firing order	1-2-4-3, counterclockwise rotation
Valve clearance, cold	0.008 to 0.010 in (0.20 to 0.25 mm) intake 0.018 to 0.020 in (0.45 to 0.50 mm) exhaust

BATTERY

The battery used in the machine is a low maintenance battery. It has been constructed with special materials and has extra electrolyte to reduce or eliminate maintenance. Its design reduces electrolyte loss and contamination. Do not add water, remove the battery vent plugs, or check the battery specific gravity. For specific instructions, see the battery label.

The battery is a 12 V, 84 A/h at a 20-hour rate. It is located under the operator foot plate. When removing battery cables, remove the negative (-) cable before the positive (+) cable.

⚠ CAUTION: Always remove the negative (-) battery cable before the positive (+) battery cable to prevent accidental electrical shorting and personal injury.

Do not allow the battery to remain in discharged condition for any length of time. Do not operate the machine if the battery is in poor condition or discharged beyond 80%, specific gravity below 1.120.

Clean the top surface and the terminals of the battery periodically. Use a strong solution of baking soda and water. Brush the solution sparingly over the battery top, terminals, and cable clamps. Do not allow any baking soda solution to enter the battery. Use a wire brush to clean the terminal posts and the cable connectors. After cleaning, apply a coating of clear petroleum jelly to the terminals and the cable connectors. Keep the top of the battery clean and dry.

Keep all metallic objects off the top of the battery, as they may cause a short circuit. Replace worn or damaged wires.

The electrolyte level in regular non-sealed batteries can be checked. It must always be above the battery plates. Add distilled water to maintain solution at the correct level above the plates, but do not overfill. Never add acid to batteries, only water. Keep vent plugs firmly in place at all times, except when adding water or taking hydrometer readings.

⚠ WARNING: Avoid contact with battery acid. Battery acid can cause severe burns. Wash immediately and get medical attention if contact with battery acid occurs.

If when checking battery specific gravity, one or more battery cells tests lower than the other battery cells, (0.050 or more) the cell is damaged, shorted, or is about to fail.

NOTE: Do not take readings immediately after adding water—if the water and acid are not thoroughly mixed, the readings may not be accurate. Check the hydrometer readings against this chart:

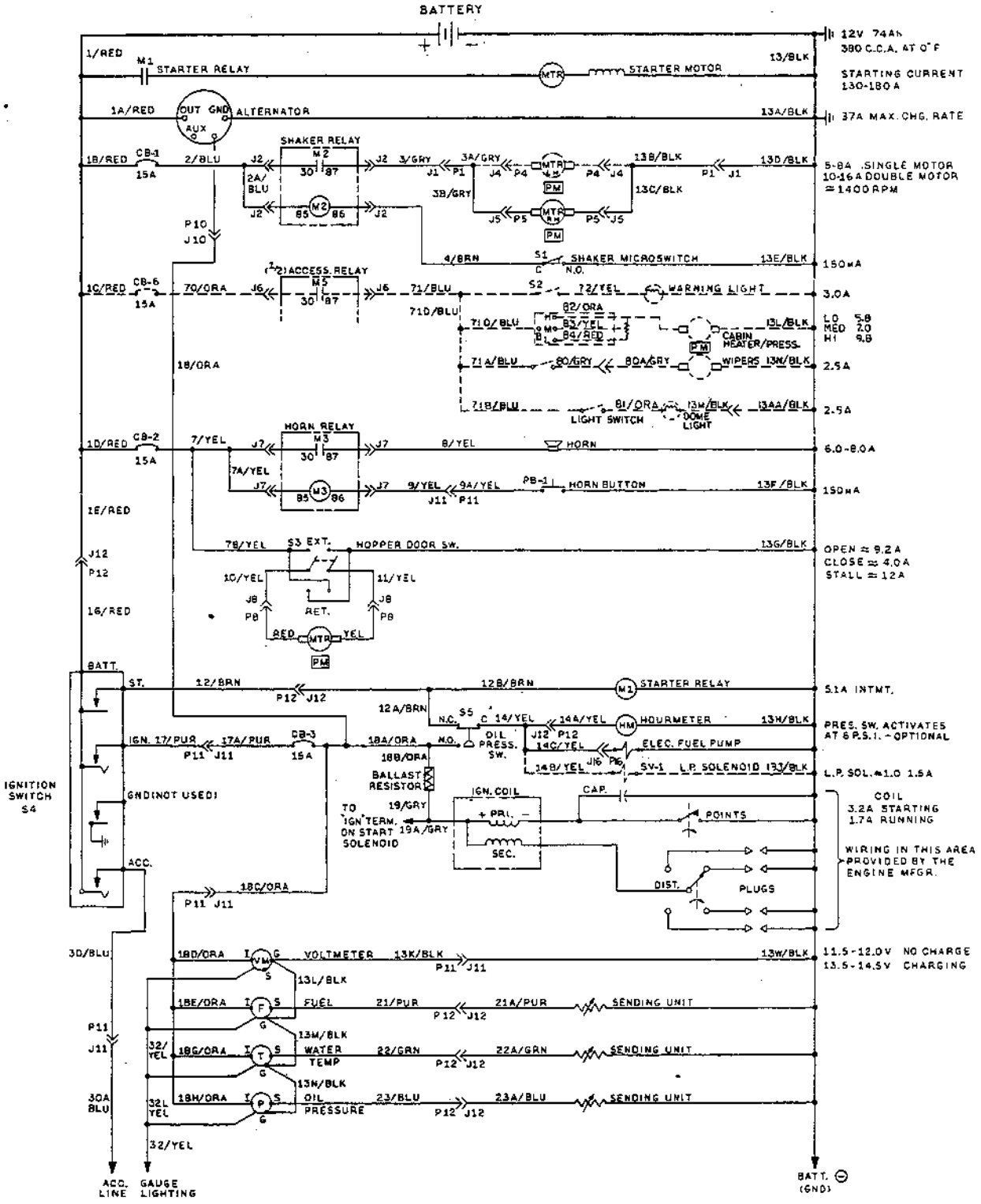
SPECIFIC GRAVITY AT 80° F (26.6° C)	BATTERY CONDITION
1.260 - 1.280	100% charged
1.230 - 1.250	75% charged
1.200 - 1.220	50% charged
1.170 - 1.190	25% charged
1.110 - 1.130	Discharged

NOTE: If the readings are taken when the battery electrolyte is any temperature other than 80° F (26.6° C), the reading must be temperature corrected.

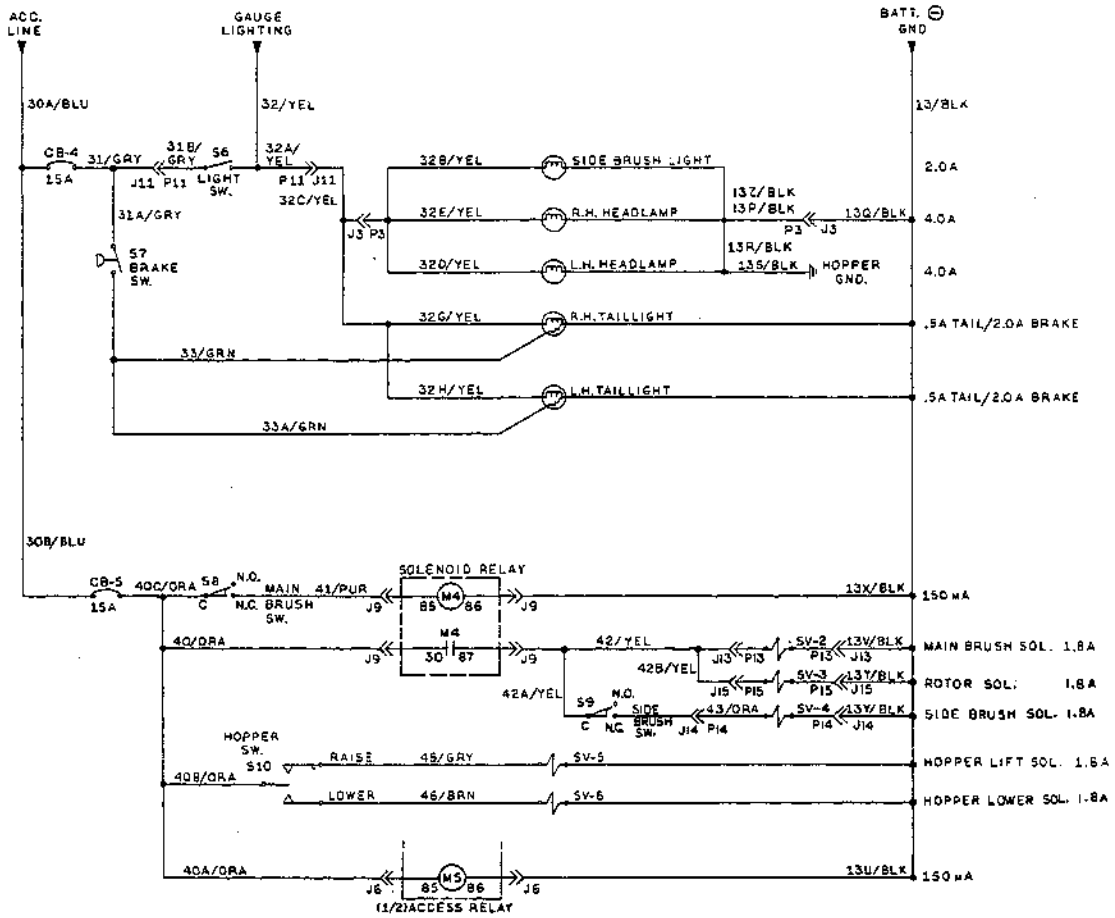
To determine the corrected specific gravity reading when the temperature of the battery electrolyte is other than 80° F (26.6° C):

Add to the specific gravity reading 0.004, 4 points, for each 10° F (5.5° C) above 80° F (26.6° C).

Subtract from the specific gravity reading 0.004, 4 points for each 10° F (5.5° C) below 80° F (26.6° C).



ELECTRICAL SCHEMATIC 02174



LEGEND	
M	POWER RELAY
MTR	MOTOR
CB	CIRCUIT BREAKER
PM	PERMANENT MAGNET
J	JACK-FEM. SOCKET
P	PLUG-MALE PIN
PB	PUSHBUTTON
VM	VOLTMETER
HM	HOURMETER
SV	SOLENOID VALVE
S	SWITCH
ACC	ACCESSORY
GND	GROUND, CHASSIS
C	COMMON
N.O.	NORMALLY OPEN
N.C.	NORMALLY CLOSED

ELECTRICAL SCHEMATIC

02174

ALTERNATOR BELT

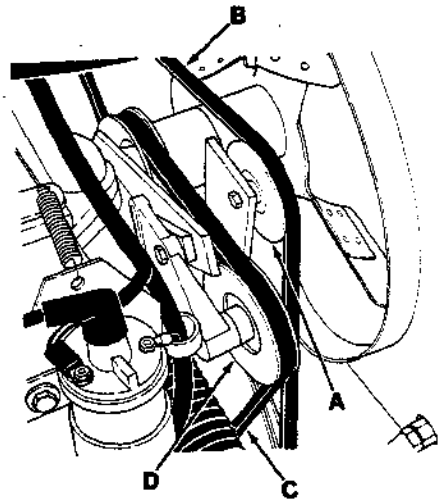
The alternator belt is driven by the engine crankshaft sheave and drives the alternator sheave. Check and adjust the alternator belt tension after every 200 hours of operation.

To tighten the alternator belt, loosen the alternator mounting bolts and pull the alternator away from the engine until the belt is snug; then tighten the bolts. Do not use a pry bar on the alternator as it will damage the alternator. Proper belt tension is obtained when the belt deflects 0.09 in (2 mm) from a force of 7 to 10 lb (3 to 4.5 kg) applied at the mid-point of the longest span.

ENGINE FAN BELT

The engine fan belt is driven by the engine crankshaft sheave and drives the engine fan sheave. Check and adjust the engine fan belt tension after every 200 hours of operation.

To tighten the engine fan belt, loosen the belt idler bracket mounting bolts, pull the idler bracket away from the engine until the belt is snug, then tighten the bolts. Proper belt tension is obtained when the belt deflects 0.25 in (6 mm) from a force of 1 to 2 lb (0.5 to 0.9 kg) applied at the mid-point of the longest span.



BELTS 02175

A. Vacuum Fan Belt Idler Sheave
B. Vacuum Fan Drive Belt
C. Engine Fan Drive Belt
D. Engine Fan Belt Idler Sheave

VACUUM FAN BELT

The vacuum fan belt is driven by the engine crankshaft sheave and drives the vacuum fan sheave. Check and adjust the vacuum fan belt alignment and tension after every 200 hours of operation.

To check belt sheave alignment, use a straight edge on the sheave faces. The vacuum fan sheave should line up with the engine crankshaft sheave within 0.06 in (1.5 mm). To tighten the vacuum fan belt, loosen the belt idler bracket mounting bolts, pull the idler bracket away from the engine until the belt is snug, and tighten the bolts. Proper belt tension is obtained when the belt deflects 0.25 in (6 mm) from a force of 3 to 4 lb (1.4 to 1.8 kg) applied at the mid-point of the longest span.

STATIC DRAG CHAIN

A static drag chain is provided to prevent the buildup of static electricity in the machine. The chain is attached to the machine by a rear brush skirt retaining bolt.

The chain should make contact with the floor at all times.

DEBRIS HOPPER

HOPPER DUST FILTER

The dust filter filters the air which is drawn up from the main brush compartment through the hopper. The dust filter is equipped with a shaker motor to remove the accumulated loose dust particles. The dust filter shaker motor is operated by the vacuum fan shut-off control lever. Shake the dust filter before dumping the hopper and at the end of every work shift. Inspect and clean or replace the dust filter after every 100 hours of operation.

To clean the dust filter, use one of the following methods:

- TAPPING - Tap the filter gently on a flat surface with the dirty side down. Do not damage the edges of the filter element or the filter will not seat properly in the filter frame.
- AIR - Blow compressed air, 35 psi (240 kPa) maximum, through the dust filter opposite the direction of the arrows. This may be done with the dust filter in the machine. Always wear eye protection when using compressed air.
- WATER - Soak the dust filter in a water and mild detergent solution. Rinse the dust filter until it is clean. The maximum water pressure allowable is 40 psi (275 kPa). Air dry the wet dust filter; do not use compressed air.

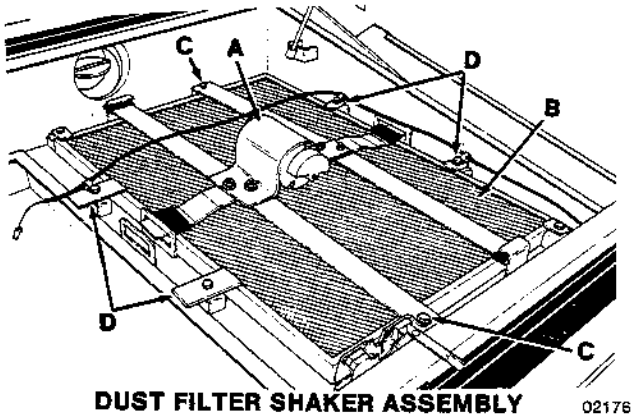
NOTE: Be sure the dust filter is dry before reinstalling it in the machine.

TO REMOVE HOPPER DUST FILTER

1. Stop the engine and engage the machine parking brake.

⚠ WARNING: Always park on a level surface, stop the engine, and engage the parking brake before working on the machine to keep it from creeping or rolling.

2. Push the hopper cover latch release lever to open the hopper cover.
3. Disconnect the shaker motor wire connectors.



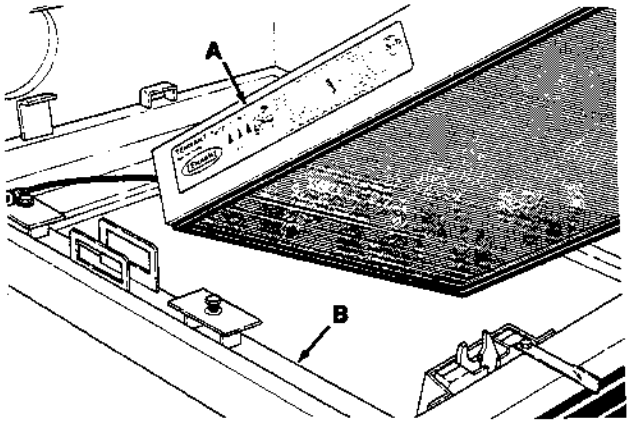
DUST FILTER SHAKER ASSEMBLY 02176

A. Dust Filter Shaker Assembly
B. Dust Filter
C. Spring Mounting Bolt
D. Filter Retaining Tab

4. Remove the dust filter spring mounting bolt from each spring.
5. Loosen the eight dust filter retaining tab bolts.
6. Rotate the retaining tabs to allow the dust filter to be removed.
7. Lift the dust filter shaker assembly off the dust filter element.
8. Lift the dust filter element out of the dust filter frame.
9. Clean or discard the dust filter as required.

TO INSTALL HOPPER DUST FILTER

1. Place the cleaned or new dust filter in the hopper dust filter frame with the arrows pointing up.



INSTALLING DUST FILTER 02177

A. Dust Filter
B. Dust Filter Frame

2. Rotate the retaining tabs to hold the dust filter in the filter frame.
3. Tighten the retaining tab bolts.

4. Slide the dust filter shaker assembly in position over the dust filter.
5. Thread the two bolts through the mounting springs and into the dust filter frame. Tighten the bolts.
6. Reconnect the shaker motor wire connectors.
7. Close the hopper cover.

HOPPER FUSIBLE LINK

The hopper fusible link is a device which, in case of a fire in the hopper, allows the hopper fire door to close, cutting off air to the fire.

The fusible link is positioned between the hopper fire door and the hopper frame. It is accessible through the hopper door.

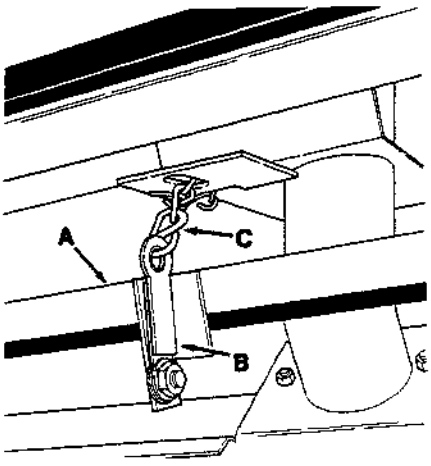
If a loss of dust control is noticed, check the fusible link for breakage or failure due to heat or vibration. Do not wire the fire door open, use a fusible link.

TO REPLACE HOPPER FUSIBLE LINK -

1. Stop the engine and engage the machine parking brake.

⚠ WARNING: Always park on a level surface, stop the engine, and engage the parking brake before working on the machine to keep it from creeping or rolling.

2. Open the vacuum wand connection door and pull the fire door chain out of chain keeper slot.
3. Open the hopper door.
4. Remove the pieces of fusible link.
5. Bolt a new fusible link to the fire door, using a washer to space the link away from the fire door. Connect the "S" hook to the free end of the link.



FUSIBLE LINK INSTALLATION 02178

A. Fire Door
B. Fusible Link
C. Chain

6. Close the hopper door.
7. Open the vacuum wand connection door and the fire door by pulling the fire door chain up and sliding it into the chain keeper slot.

DEBRIS HOPPER

The debris hopper collects all of the debris swept up by the machine. The hopper has four areas of adjustment. They are: hopper lift linkage, hopper stops, arm lock bracket, and hopper adjustments. All of the adjustments have been made at the factory and require no regular maintenance. In the event that the hopper components are repaired or replaced, the hopper must be readjusted for best performance.

The hopper adjustments must be made in the order specified. Make all adjustments with the engine off and parking brake engaged. If the adjustments are made with the hopper raised, be sure to engage the hopper safety support bar.

TO ADJUST HOPPER

NOTE: Empty the debris hopper and temporarily remove the hopper lift linkage side panels to more easily make the adjustments.

A. HOPPER LIFT LINKAGE

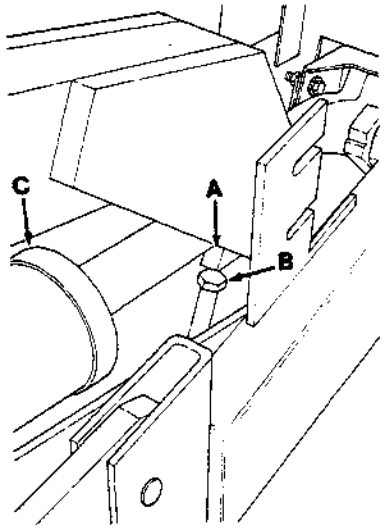
1. Stand clear and cycle the hopper up and down. Watch for signs of binding, sloppiness, or misalignment of the lift arm linkage. Reshim to remove binding, sloppiness, or misalignment of the linkage as necessary.

⚠ WARNING: Stand clear of hopper and hopper linkage whenever the hopper is raised or in motion.

B. HOPPER STOPS

1. The two top hopper stop bolts, one on each side, prevent the lift cylinders from over extending. Adjust the stop bolts so the lift linkage stops against the bolts and still allows the hopper to raise to the required height.

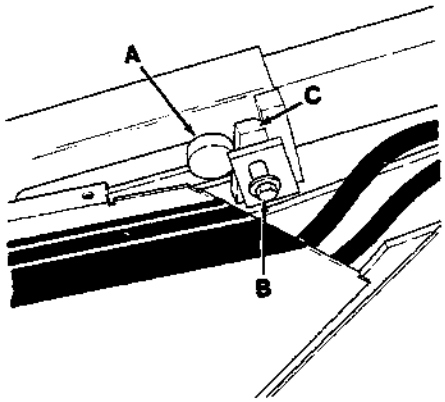
2. The bottom stop bolts prevent the lift cylinders from bottoming. Loosen the jam nut on each down stop bolt. Thread the bolts into the frame. Extend each hydraulic cylinder 0.38 in (10 mm) from its "fully retracted" position. Thread the stop bolt out of the frame until the bolt contacts the bottom of the lift linkage. Secure the stop bolt positions with the jam nuts.



STOP BOLT 02179

A. Lift Linkage
B. Stop Bolt
C. Hydraulic Cylinder

3. The upper arm wedge stop allows adjustment so both upper arm slider pins contact their stops at the same time as the hopper is being rolled out. Roll out the hopper and observe the slider pins. If they do not top out at the same time, loosen the wedge stop bolt on the top left lift arm and move the wedge to match the travel of the right slider pin. Tighten the wedge stop bolt and check to make sure the pins stop at the same time. Readjust as necessary.

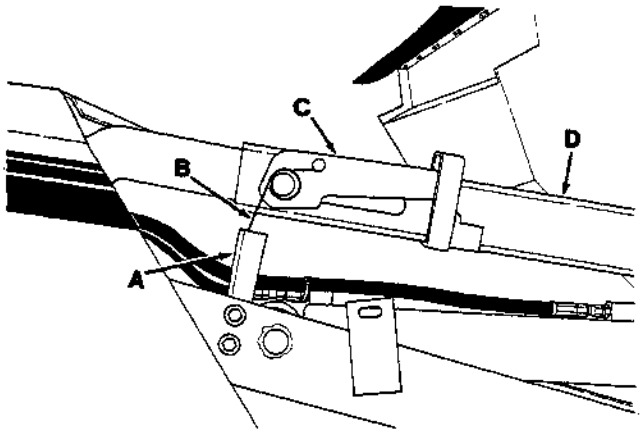


WEDGE STOP 02180

A. Left Slider Pin
B. Wedge Stop Bolt
C. Wedge Stop

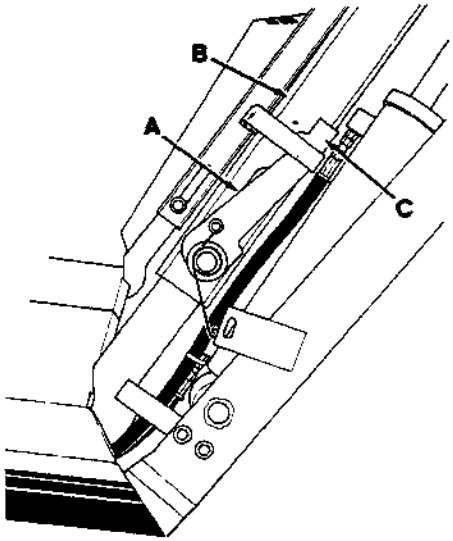
C. ARM LOCK BRACKET

1. The arm lock bracket locks the upper lift arm in the "fully extended" position when the hopper is in the "raised" position. This prevents the hopper from rolling back in the event the operator tries to lower the hopper and it becomes jammed or hung up. The arm lock bracket must be adjusted so it drops and latches when the hopper is raised and unlatches when the hopper is lowered. Adjust the locking strip so the spring lifts the bracket as it comes in contact with the locking strip, and lowers the bracket as it looses contact with the strip.



DISENGAGED ARM LOCK BRACKET 02181

A. Locking Strip
B. Spring
C. Arm Lock Bracket
D. Lift Arm



ENGAGED ARM LOCK BRACKET 02182

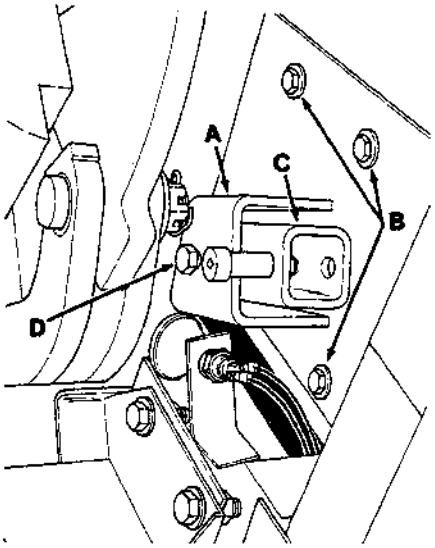
A. Arm Lock Bracket
B. Lift Arm
C. Lift Arm Stop

D. HOPPER ADJUSTMENTS

1. The side-to-side and front-to-back adjustments allow the hopper to be centered in the machine. Make sure the hopper does not interfere with any other parts when in motion. One bolt on each side of the hopper adjusts

the side-to-side position. Loosen both bolts before making an adjustment. Tightening one bolt closes the gap on its side of the hopper. Tighten both bolts after the hopper is centered side-to-side with respect to the hopper lift arms.

Five bolts on each side of the hopper adjust the front-to-back position. Loosen all of the bolts, reposition the hopper, and tighten the bolts.

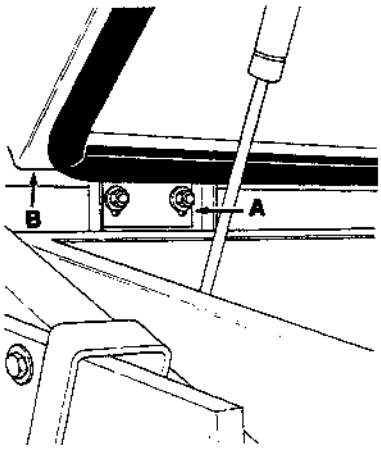


02183

HOPPER POSITION ADJUSTMENT BOLTS

A. Hopper
B. Front-to-Back Adjustment Bolts
C. Hopper Pivot
D. Side-to-Side Adjustment Bolt

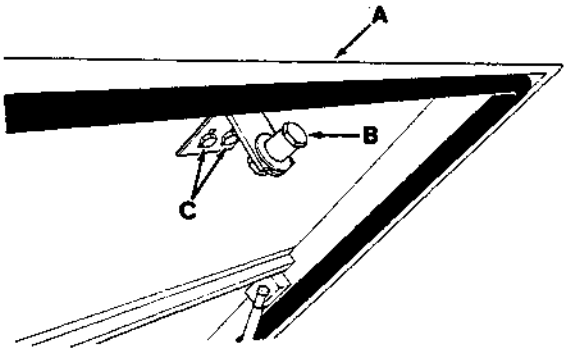
2. The hopper cover hinges and latch determine the tightness of the hopper cover seal. Adjust the hinges and latch so the entire seal is compressed evenly. The hopper cover hinges have slots to allow adjustment.



HOPPER COVER HINGE 02161

A. Hinge
B. Hopper Cover

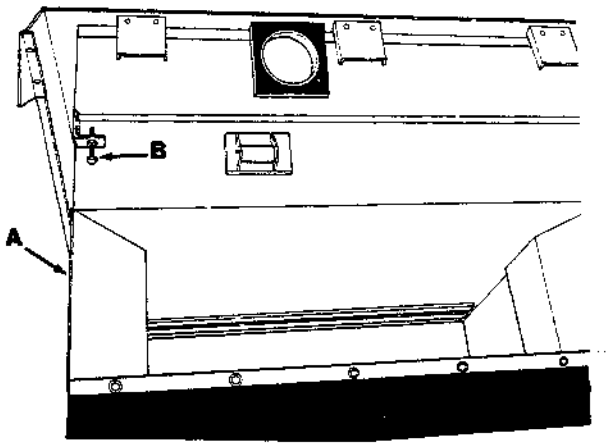
The latch height is adjusted by loosening, repositioning, and tightening the latch striker. The latch position can also be adjusted by loosening, repositioning, and retightening the latch bracket mounting bolts.



HOPPER COVER LATCH STRIKER 02184

A. Hopper Cover
B. Latch Striker
C. Mounting Bolt

3. The two rear hopper stops determine the height of the rear of the hopper. Adjust the stop bolts so the rear of the hopper is 0.31 to 0.50 in (10 to 15 mm) lower than and parallel to the relay panel cover and the valve cover panel.

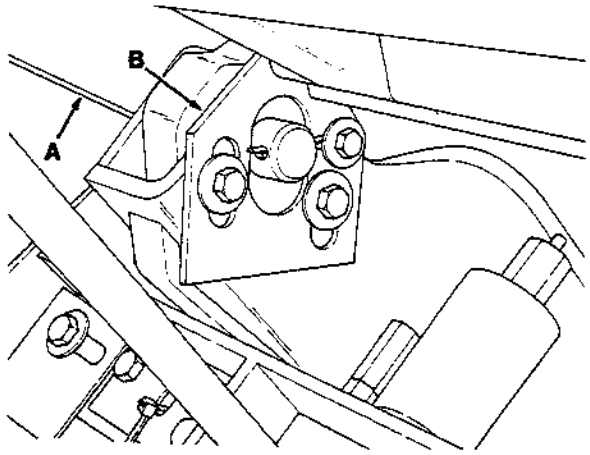


REAR HOPPER STOP BOLTS 02170

A. Hopper
B. Stop Bolt

The relay panel cover and valve cover panels should also be level side-to-side. Slots have been provided in the panel hinges to allow adjustment of the panel positions.

The relay panel cover and valve cover panels should also be level side-to-side. Slots have been provided in the panel hinges to allow adjustment of the panel positions.



VALVE COVER PANEL HINGE 02185

A. Valve Cover Panel
B. Hinge

4. The front bumper should be aligned with the side bumpers without interference.

E. OTHER ADJUSTMENTS

The vacuum fan-to-hopper seal and speed limiter must be readjusted after adjusting the hopper. See To Adjust Vacuum Fan Shutoff and Speed Limiter.

MAIN BRUSH

The main brush is tubular and runs the width of the machine, sweeping debris into the debris hopper. It should be inspected daily for wear or damage. Remove any string or wire found tangled on the main brush, main brush drive hub, or main brush idler hub.

Rotate the main brush end-for-end after every 50 hours of operation for maximum brush life and best sweeping performance.

The main brush pattern should be checked daily. It should be 2 to 2.5 in (50 to 65 mm) wide with the main brush in the "normal" position. Main brush pattern adjustments are made by turning the height adjustment knob behind the side shroud next to the operator's left leg.

The main brush should be replaced when the remaining bristles measure 1.25 in (30 mm) in length.

TO REPLACE MAIN BRUSH

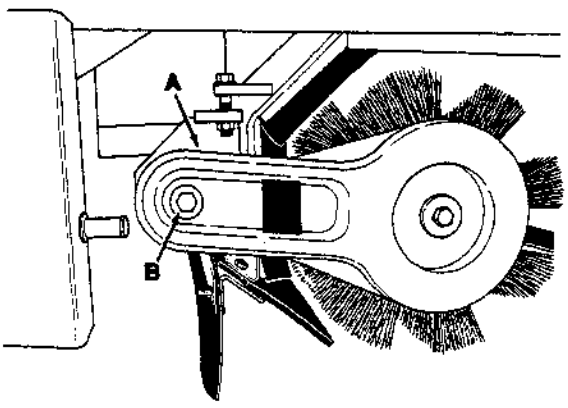
1. Stop the engine and engage the machine parking brake.

⚠ WARNING: Always park on a level surface, stop the engine, and engage the parking brake before working on the machine to keep it from creeping or rolling.

2. Place the main brush in the "free-float" position.

⚠ CAUTION: Wear gloves to protect your hands when replacing the main brush. Brush bristles and trapped debris may injure hands.

3. Open the right side main brush door.
4. Remove the brush idler arm retaining bolt from the arm hub.



MAIN BRUSH IDLER ARM 02186

A. Brush Idler Arm
B. Arm Retaining Bolt

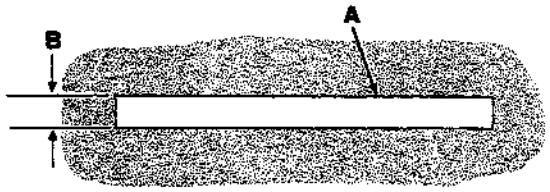
5. Pull the brush idler arm off the arm hub.
6. Grasp the main brush; pull it off the brush drive plug and out of the main brush compartment.
7. Place the new or rotated end-for-end main brush on the floor next to the access door.
8. Align the main brush drive slots with the drive keys on the main brush drive plug.
9. Slide the main brush into the brush compartment and onto the drive plug. Make sure the drive slots and keys mate.
10. Align the main brush idler plug slots with the main brush keys.
11. Slide the main brush idler plug into the main brush tube.
12. Slide the brush idler arm onto the arm hub.
13. Thread the brush idler arm retaining bolt through the idler arm and into the arm hub.
14. Tighten the brush idler arm retaining bolt.
15. Close the right side main brush door.
16. Check and adjust the main brush pattern as described in To Check and Adjust Main Brush Pattern.

TO CHECK AND ADJUST MAIN BRUSH PATTERN

1. Apply chalk, or some other material that will not blow away easily, to a smooth, level floor.
2. With the side brush and main brush in the "up-off" position, position the main brush over the chalked area.
3. Place the main brush control lever in the "normal" position for 15 to 20 seconds while keeping a foot on the brakes to keep the machine from moving. This will lower and start the main brush rotating.
4. Place the main brush control lever in the "up-off" position.

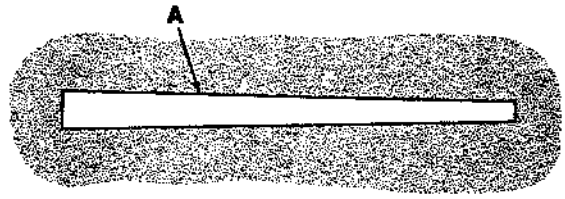
NOTE: If chalk or other material is not available, allow the brushes to spin for two minutes.

5. Drive the machine off the test area.
6. Observe the width of the brush pattern. The proper brush pattern width is 2 to 2.5 in (50 to 65 mm).



NORMAL MAIN BRUSH PATTERN 00582

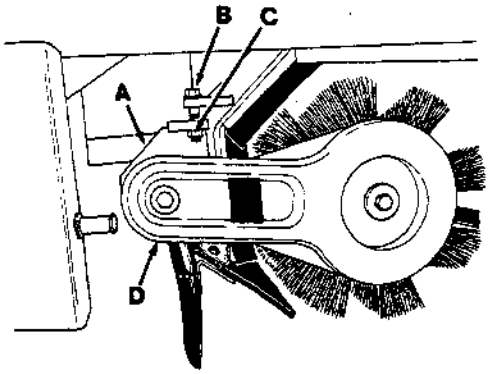
A. Main Brush Pattern
B. 2 to 2.5 in (50 to 65 mm)



TAPERED MAIN BRUSH PATTERN 00601

A. Main Brush Pattern

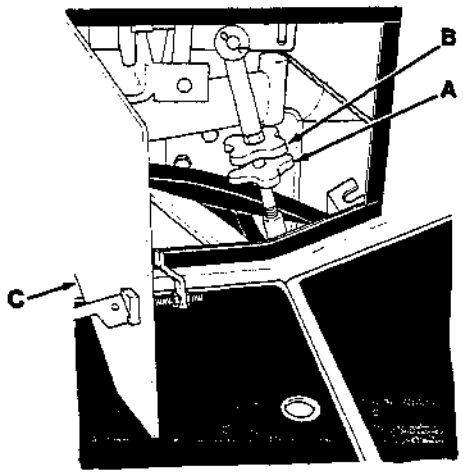
If the main brush pattern is tapered, remove the main brush idler arm. Loosen the right side main brush cross shaft bearing mounting bracket bolts and brush leveling bolt jam nut. Adjust the brush leveling bolt and pivot the bearing mounting bracket to level the cross shaft. Tighten the bearing mounting bracket and the jam nut. Replace the main brush idler arm. Check the main brush pattern and readjust as necessary. Then adjust the width of the main brush pattern.



MAIN BRUSH LEVELING BOLT 02186

A. Bearing Mounting Bracket
B. Leveling Bolt
C. Jam Nut
D. Idler Arm

To widen the main brush pattern, loosen the main brush height adjustment lock knob and turn the height adjustment knob counterclockwise from the top. To reduce the width of the main brush pattern, loosen the lock knob and turn the adjustment knob clockwise from the top. Tighten the lock knob against the adjustment knob and recheck the main brush pattern. Repeat the procedure until the main brush pattern is within specified range.



02150

MAIN BRUSH HEIGHT ADJUSTMENT KNOB

A. Height Adjustment Knob
B. Lock Knob
C. Access Door

ROTARY SEAL™

The Rotary Seal™ loads the hopper with debris picked up by the main brush and seals the main brush compartment. It should be inspected daily for wear or damage, and adjustment. Remove any string or wire found tangled on the Rotary Seal™ or drive hub.

The Rotary Seal™ blades should clear the floor by 0.12 in (5 mm). The height adjustment is made by adjusting the two stop bolts. The Rotary Seal™ side shields should clear the side of the main frame by 0.12 in (5 mm).

TO REPLACE ROTARY SEAL™ BLADES

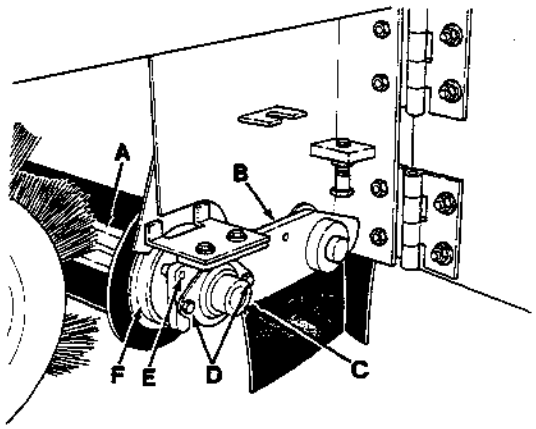
1. Empty the debris hopper.
2. Raise the hopper, engage the hopper safety support bar, and lower the hopper onto the support bar.

⚠ WARNING: Always engage the hopper safety support bar before working under a raised hopper. Do not rely on the machine hydraulic system to keep the hopper in the "raised" position. The hydraulic system may leak internally, allowing the hopper to lower, crushing anything under it.

3. Stop the engine and engage the machine parking brake.

⚠ WARNING: Always park on a level surface, stop the engine, and engage the parking brake before working on the machine to keep it from creeping or rolling.

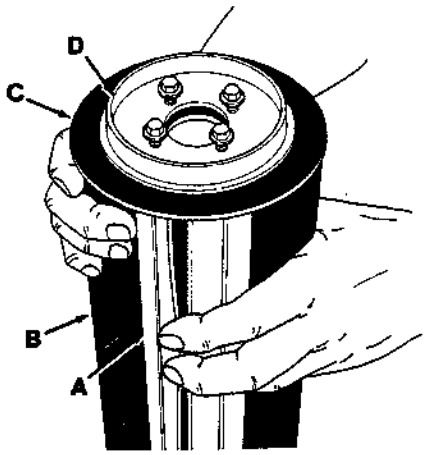
4. Place the main brush control lever in the "normal" position.
5. Open the right and left side main brush doors.
6. Remove the two bearing flange bolts.



IDLER ARM 02187

A. Rotary Seal™ Retainer
B. Idler Arm
C. Locking Collar
D. Bearing Flange Bolt
E. String Guard Bolt
F. String Guard

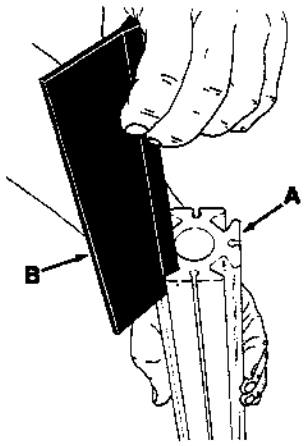
7. Loosen the bearing locking collar set screws; remove the locking collar.
8. Remove the two string guard bolts.
9. Remove the bolt that goes through the drive end of the Rotary Seal™ retainer.
10. Slide the Rotary Seal™ assembly off the idler arm and drive coupling.
11. Slide the Rotary Seal™ assembly out of the machine.
12. Remove the four ring retaining bolts on each end of the Rotary Seal™.



ROTARY SEAL™ 02188

A. Seal Retainer
B. Rotary Seal™ Blade
C. Ring
D. Ring Retainer

13. Remove the ring retainer and rings.
14. Slide the existing Rotary Seal™ blades out of the seal retainer.
15. Slide new blades into the seal retainer.



02189

INSTALLING NEW ROTARY SEAL™ BLADES

A. Seal Retainer
B. Rotary Seal™ Blade

16. Secure a new ring and a ring retainer to each end of the seal retainer.
17. Slide the drive end of the Rotary Seal™ assembly onto the drive coupling. Be sure the drive hole on the coupling and seal retainer line up.
18. Slide the Rotary Seal™ assembly up onto the idler arm.
19. Start the string guard bolts to hold assembly in place.
20. Replace bolt through seal retainer and drive coupling.

21. Secure string guard bolts.
22. Replace bearing locking collar.
23. Replace the two bearing flange bolts.
24. Secure the bearing locking collar set screws.
25. Adjust the Rotary Seal™ as described in To Adjust Rotary Seal™.

TO ADJUST ROTARY SEAL™

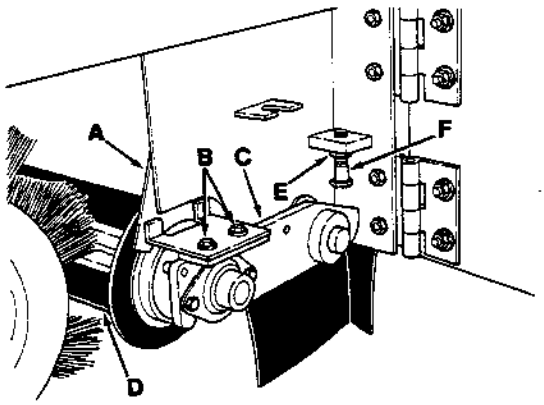
1. Empty the debris hopper.
2. Raise the hopper, engage the hopper safety support bar, and lower the hopper onto the support bar.

⚠ WARNING: Always engage the hopper safety support bar before working under a raised hopper. Do not rely on the machine hydraulic system to keep the hopper in the "raised" position. The hydraulic system may leak internally, allowing the hopper to lower, crushing anything under it.

3. Stop the engine and engage the machine parking brake.

⚠ WARNING: Always park on a level surface, stop the engine, and engage the parking brake before working on the machine to keep it from creeping or rolling.

4. Place the main brush control lever in the "normal" position.
5. Open the right and left side main brush doors.
6. Measure the distance between the bottom of the Rotary Seal™ blades and the floor. There should be 0.12 in (5 mm) clearance. Adjust the stop bolt on each side of the machine to adjust Rotary Seal™ height. Tighten the stop bolts jam nut to secure adjustment.



02187

ROTARY SEAL™

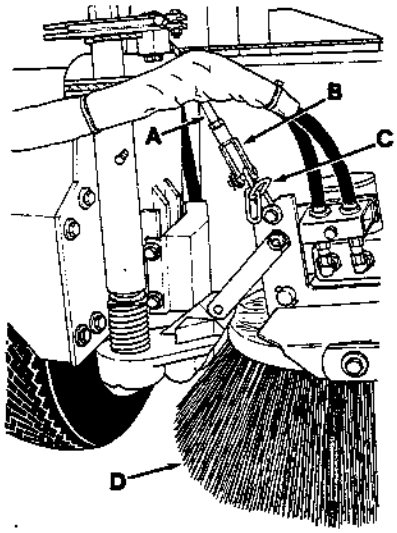
A. Side Shield
B. Adjustment Bolt
C. Idler Arm
D. Rotary Seal™
E. Jam Nut
F. Stop Bolt

7. Loosen the side shield adjustment bolts.
8. Slide the side shield in or out until there is a 0.12 in (5 mm) space between the side shield and the machine frame. Tighten the adjustment bolts.

SIDE BRUSH

The side brush sweeps debris from curbs or gutters into the path of the main brush. It should be inspected daily for wear or damage. Remove any string or wire found tangled on the side brush or side brush drive hub.

The side brush pattern should be checked daily. The side brush should just contact the floor when the brush is in motion. Side brush pattern adjustments are made by adjusting the clevis on the side brush lift cable or by connecting the clevis to a different link of the side brush lift chain.

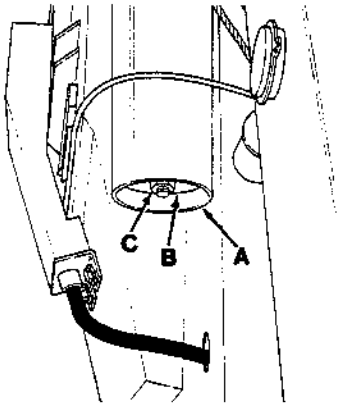


02158

SIDE BRUSH LIFT CHAIN AND CLEVIS

A. Lift Cable
B. Clevis
C. Lift Chain
D. Side Brush

Two other cables control the in-out movement of the side brush. They require no regular adjustment. When replacing the cable which pulls the side brush in as the hopper raises, adjust the cable so the front of the side brush swings in even with the front of the machine frame. When replacing the cable which pulls the side brush out, adjust the cable so the spring backing plate is 0.5 in (15 mm) inside of the spring tube when the side brush is in the "operating" position and the hopper is in the "rolled-out and lowered" position.



SPRING BACKING PLATE 02190

A. Spring Tube
B. Backing Plate
C. Cable Adjustment Nut

The side brush should be replaced when the remaining brush bristle measures 2.5 in (65 mm) in length.

TO REPLACE SIDE BRUSH

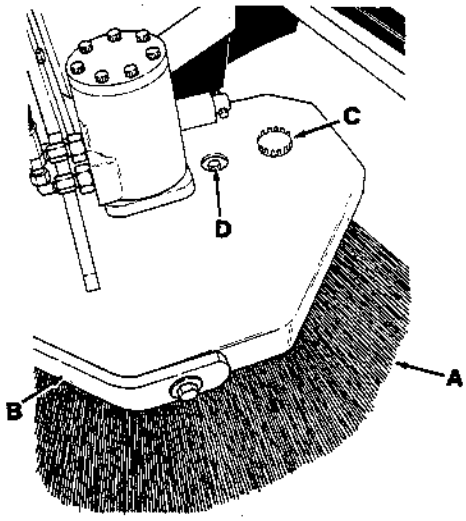
1. Empty the debris hopper.
2. Raise the hopper, engage the hopper safety support bar, and lower the hopper onto the support bar.

⚠ WARNING: Always engage the hopper safety support bar before working under a raised hopper. Do not rely on the machine hydraulic system to keep the hopper in the "raised" position. The hydraulic system may leak internally, allowing the hopper to lower, crushing anything under it.

3. Place the main brush control lever in the "normal" position.
4. Stop the engine and engage the machine parking brake.

⚠ WARNING: Always park on a level surface, stop the engine, and engage the parking brake before working on the machine to keep it from creeping or rolling.

5. Remove the plugbutton from the top of the side brush bumper.



SIDE BRUSH 02191

A. Side Brush
B. Side Brush Bumper
C. Plugbutton
D. Side Brush Retaining Bolt

6. Rotate the side brush by hand until a bolt appears through the hole in the side brush bumper. Remove the bolt.

   Remove all four of the side brush retaining bolts to remove the side brush.

7. Position the new side brush under the side brush bumper. Line up one of the four side brush mounting holes with the hole in the side brush bumper and side brush adapter.
8. Secure the side brush to the side brush adapter with the bolts removed earlier.
9. Adjust the side brush pattern.
10. Disengage the hopper safety support bar and lower the hopper.

HOPPER LIP SKIRT

The hopper lip skirt is located on the bottom rear of the hopper. Its purpose is to float over debris, control dust and help deflect the debris into the hopper.

The hopper lip skirt should be inspected for wear or damage daily.

TO REPLACE HOPPER LIP

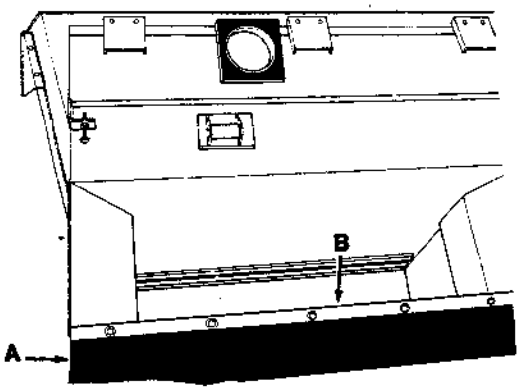
1. Empty the machine debris hopper.
2. Stop the machine on a level surface and engage the machine parking brake.
3. Raise the hopper, engage the hopper safety support bar, and lower the hopper onto the hopper safety support bar.

⚠ WARNING: Always engage the hopper safety support bar before working under a raised hopper. Do not rely on the machine hydraulic system to keep the hopper in the "raised" position. The hydraulic system may leak internally, allowing the hopper to lower, crushing anything under it.

4. Stop the engine.

⚠ WARNING: Always park on a level surface, stop the engine, and engage the parking brake before working on the machine to keep it from creeping or rolling.

5. Remove the hopper lip retaining strip mounting bolts.



HOPPER LIP SKIRT 02170

A. Hopper Lip Skirt
B. Retaining Strip

6. Remove the hopper lip retaining strip and worn or damaged hopper lip.
7. Thread the retaining strip mounting bolts through the retaining strip, the hopper lip segment, and into the hopper.
8. Tighten the mounting bolts.
9. Start the engine.
10. Raise the hopper, lower the hopper safety support bar, and lower the hopper.
11. Stop the engine.

BRUSH DOOR SKIRTS

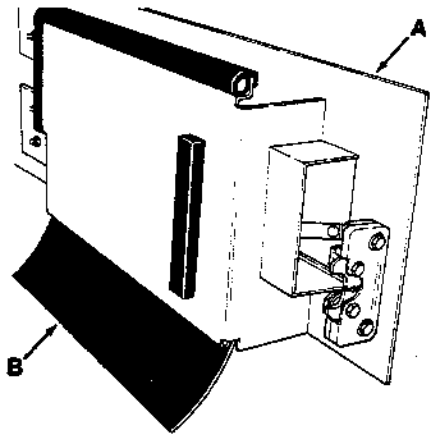
The brush door skirts are located on the bottom of each of the two main brush doors. They seal the main brush compartment. The skirts should be inspected for wear or damage and adjustment daily.

TO REPLACE AND ADJUST BRUSH DOOR SKIRTS

1. Stop the machine on a smooth, level surface.
2. Stop the engine and engage the machine parking brake.

⚠ WARNING: Always park on a level surface, stop the engine, and engage the parking brake before working on the machine to keep it from creeping or rolling.

3. Open the main brush doors.
4. Remove the brush door skirt retaining bolts.



BRUSH DOOR SKIRT 02162

A. Brush Door
B. Brush Door Skirt

5. Remove the skirt retaining strip and the door skirt.
6. Position the new door skirt and skirt retaining strip on the brush door.

7. Thread the skirt retaining bolts through the brush door, the door skirt, and into the skirt retaining strip.

NOTE: The brush door skirts have slotted holes to allow for a ground clearance adjustment. The door must be closed for proper adjustment.

8. Slide the brush door skirt up or down so that the skirt clears the floor up to 0.12 in (5 mm).
9. Tighten the skirt retaining bolts.
10. Close the brush doors.

REAR SKIRTS

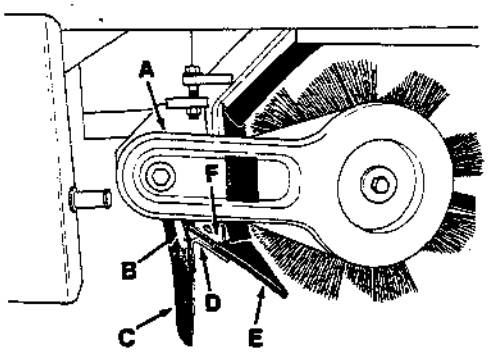
The skirts are located on the bottom rear of the main brush compartment. They seal the main brush compartment. The seals should be inspected for wear or damage and adjustment daily.

TO REPLACE AND ADJUST THE REAR SKIRTS

1. Stop the machine on a smooth, level surface.
2. Stop the engine and engage the machine parking brake.

⚠ WARNING: Always park on a level surface, stop the engine, and engage the parking brake before working on the machine to keep it from creeping or rolling.

3. Open the main brush doors.



REAR SKIRTS 02186

A. Brush Idler Arm
B. Skirt Retaining Strip
C. Rear Floor Skirt
D. Skirt Mounting Angle
E. Brush Contact Skirt
F. Skirts Mounting Bracket

4. Remove the main brush as described in To Replace Main Brush.
5. Remove the front skirts mounting bracket retaining bolts. Remove the skirts assembly in one piece.
6. Disassemble the skirts assembly.
7. Reassemble the skirts assembly with a new floor skirt and brush skirt.
8. Reinstall the skirts assembly in the machine.
9. Slide the rear floor skirt up or down so that the skirt clears the floor up to 0.12 in (5 mm).
10. Tighten the retaining bolts.
11. Reinstall the main brush.

HOPPER SIDE SKIRTS

The hopper side skirts are located on the bottom front sides of the main brush compartment. They seal the main brush compartment. The seals should be inspected for wear or damage and adjustment daily.

TO REPLACE AND ADJUST HOPPER SIDE SKIRTS

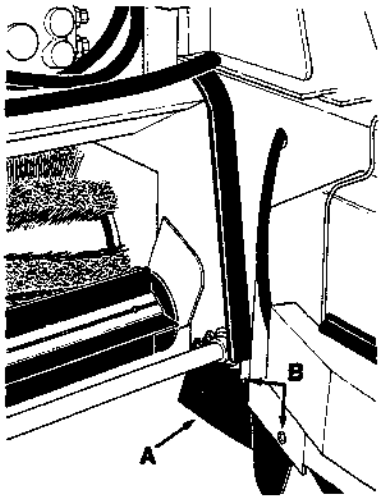
1. Empty the machine debris hopper.
2. Stop the machine on a level surface and engage the machine parking brake.
3. Raise the hopper, engage the hopper safety support arm, and lower the hopper onto the hopper safety support bar.

⚠ WARNING: Always engage the hopper safety support bar before working under a raised hopper. Do not rely on the machine hydraulic system to keep the hopper in the "raised" position. The hydraulic system may leak internally, allowing the hopper to lower, crushing anything under it.

4. Stop the engine.

⚠ WARNING: Always park on a level surface, stop the engine, and engage the parking brake before working on the machine to keep it from creeping or rolling.

5. Open the main brush doors.
6. Remove the hopper side skirt retaining strips.
7. Remove the side skirts.



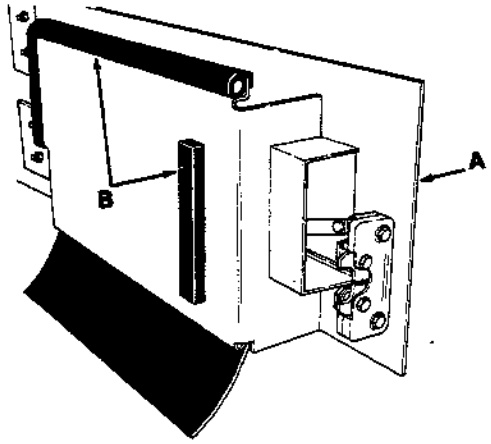
HOPPER SIDE SKIRTS 02182

A. Side Skirt
B. Retaining Bolt

8. Loosely install new side skirts with the retaining strips.
9. Slide the skirt up or down so the skirt clears the floor up to 0.12 in (5 mm).
10. Tighten the retaining bolts.
11. Start the engine.
12. Raise the hopper, disengage the safety bar, and lower the hopper.
13. Stop the engine.

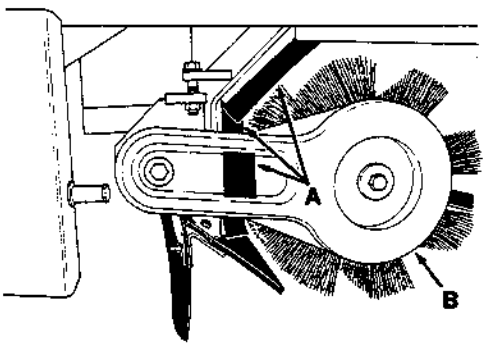
MAIN BRUSH DOOR SEALS

The main brush door seals are located on both main brush doors and on corresponding portions of the main frame. They seal the main brush compartment. The seals should be inspected for wear or damage after every 100 hours of operation.



MAIN BRUSH DOOR SEALS 02162

A. Main Brush Door
B. Door Seals

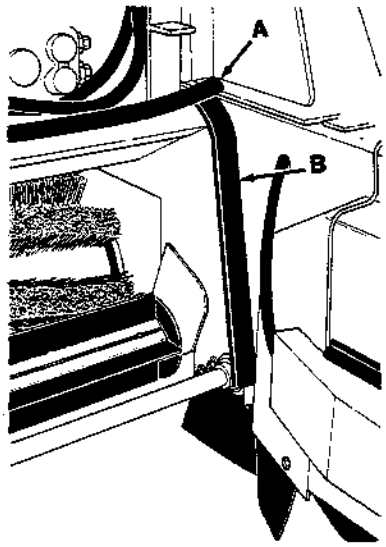


MAIN BRUSH COMPARTMENT SEALS 02186

A. Door Seals
B. Main Brush Idler Arm

HOPPER SEALS

The hopper seals are located on the top and side portions of the machine frame which contacts the hopper. They seal the main brush compartment. The seals should be inspected for wear or damage after every 100 hours of operation.

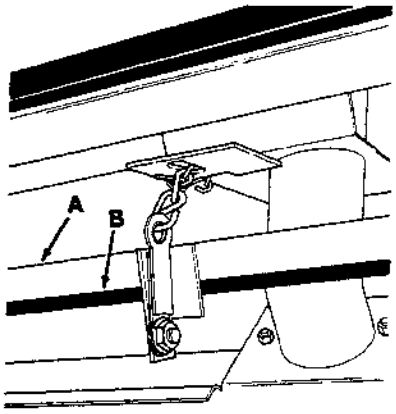


HOPPER SEALS 02192

A. Top Seal
B. Side Seal

FIRE DOOR SEAL

The fire door seal is located on the fire door. It seals the debris compartment from the filter compartment in case of fire, and also whenever the vacuum wand accessory is being used. The seal should be checked for wear or damage after every 100 hours of operation.

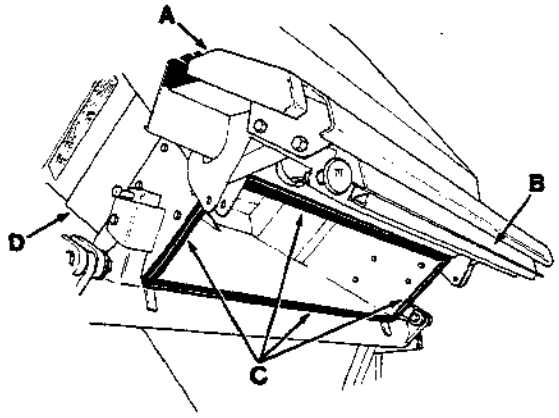


FIRE DOOR SEAL 02178

A. Fire Door
B. Door Seal

HOPPER DOOR SEALS

The hopper door seals are located on the top and side door contact edges of the hopper and the bottom edge of the hopper door. They seal the hopper door. The seals should be checked for wear or damage after every 100 hours of operation.

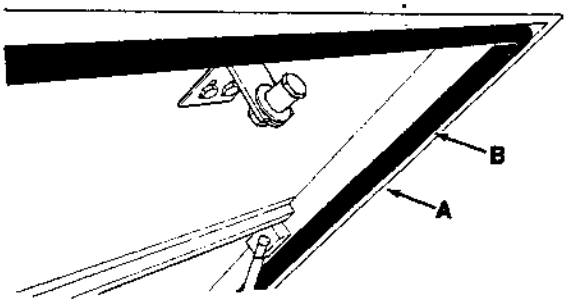


HOPPER DOOR SEALS 02193

A. Hopper Door
B. Bottom Seal
C. Hopper Mounted Seals
D. Hopper

HOPPER COVER SEAL

The hopper cover seal is located on the bottom of the hopper cover. It seals the hopper filter compartment. The seal should be checked for wear or damage after every 100 hours of operation. Check to make sure the seal is evenly compressed. Adjust the hopper cover hinges and latch striker to adjust seal compression as described in To Adjust Hopper.

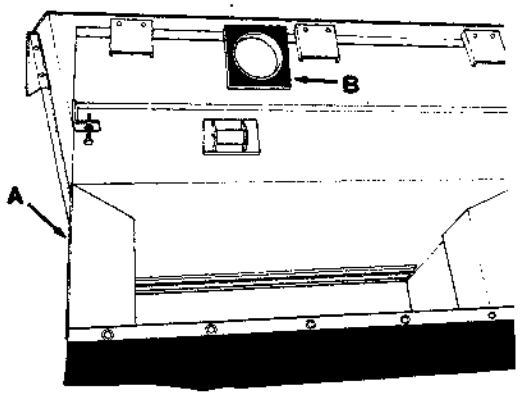


HOPPER COVER SEAL 02184

A. Hopper Cover
B. Cover Seal

HOPPER VACUUM FAN SEAL

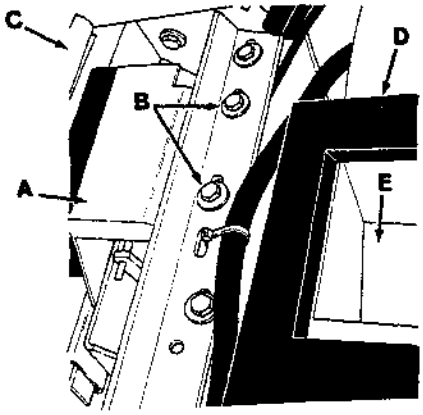
The hopper vacuum fan seal is located on the rear of the hopper. It seals the hopper filter compartment to the vacuum fan intake bracket. The seal should be checked for wear or damage after every 100 hours of operation. Check to make sure that the seal is making good contact with the vacuum fan intake bracket. The seal should be compressed 0.12 in (5 mm) by the contact.



HOPPER VACUUM FAN SEAL 02170

A. Hopper
B. Seal

To adjust seal contact, loosen the vacuum fan intake bracket mounting bolts. Pivot the bracket into the correct position and retighten the bolts.

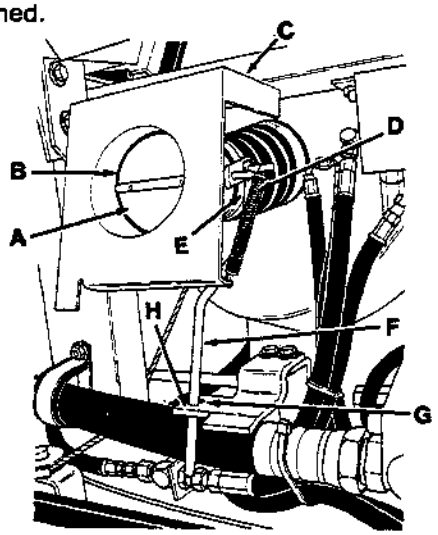


VACUUM FAN INTAKE BRACKET 02194

A. Intake Bracket
B. Bracket Bolt
C. Engine Cover
D. Fan Exhaust Seal
E. Vacuum Fan

VACUUM FAN SHUTOFF SEAL

The vacuum fan shutoff seal is located in the vacuum fan intake bracket. The shutoff controls the vacuum to the hopper filter compartment. The seal should be checked for wear or damage after every 100 hours of operation. The seal can be removed by removing the two seal retainer screws. Sandwich the new seal between the seal retainers and secure the assembly with the screws removed earlier. The shutoff control is factory adjusted and should only need adjustment after replacing one of the shutoff linkage components or after the vacuum fan intake bracket has been repositioned.



VACUUM FAN SHUTOFF 02169

A. Seal Retainer
B. Seal
C. Vacuum Fan Intake Bracket
D. Return Spring
E. Clevis
F. Rod
G. Roll Pin
H. Speed Limiter Bracket

TO ADJUST VACUUM FAN SHUTOFF

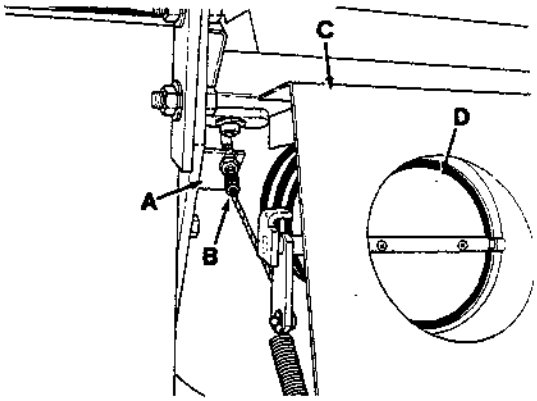
1. Empty the machine debris hopper.
2. Stop the machine on a level surface and engage the machine parking brake.
3. Raise the hopper, engage the hopper safety support bar, and lower the hopper onto the hopper safety bar.

⚠ WARNING: Always engage the hopper safety support bar before working under a raised hopper. Do not rely on the machine hydraulic system to keep the hopper in the "raised" position. The hydraulic system may leak internally, allowing the hopper to lower, crushing anything under it.

4. Stop the engine.

⚠ WARNING: Always park on a level surface, stop the engine, and engage the parking brake before working on the machine to keep it from creeping or rolling.

5. Place the vacuum shutoff control lever in the "open" position.
6. Adjust the rod clevis so the shutoff seal is in a "vertical" position, stopping air flow.
7. Push the speed limiter bracket down—the shutoff seal should move into a "horizontal" position, allowing air to flow.
8. Place the vacuum shutoff control lever in the "close" position. The shutoff seal should remain in the "vertical" position even if the speed limiter bracket is pushed down. Adjust the shutoff cable position on the cable retaining bracket to adjust the shutoff seal.



VACUUM FAN SHUTOFF CABLE 02196

A. Cable Retaining Bracket
B. Shutoff Cable
C. Vacuum Fan Intake Bracket
D. Seal Retainer

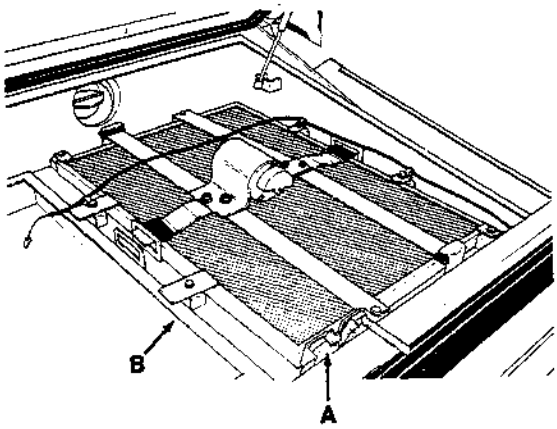
9. Start the engine.
10. Raise the hopper, disengage the hopper safety support bar, and lower the hopper.
11. Stop the engine.

LATCHES

HOPPER COVER LATCH

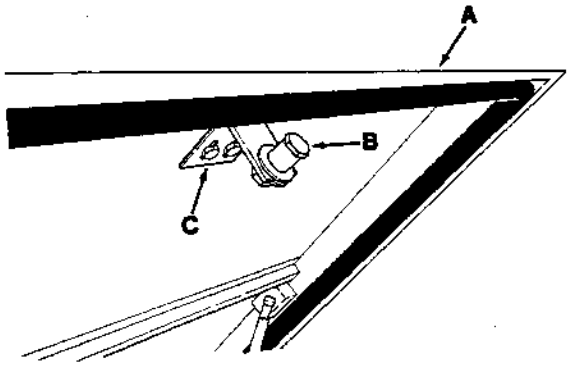
The hopper cover latch keeps the hopper cover in place when dumping the debris hopper. Pushing the latch lever to the right releases the latch. It can be lubricated with a dry lubricant. The latch should be adjusted to make the hopper cover compress the hopper cover seal.

The latch mechanism is in a fixed position. To adjust the latching action, the latch striker or latch mounting bracket must be loosened, repositioned, and tightened.



HOPPER COVER LATCH 02176

A. Latch
B. Filter Frame

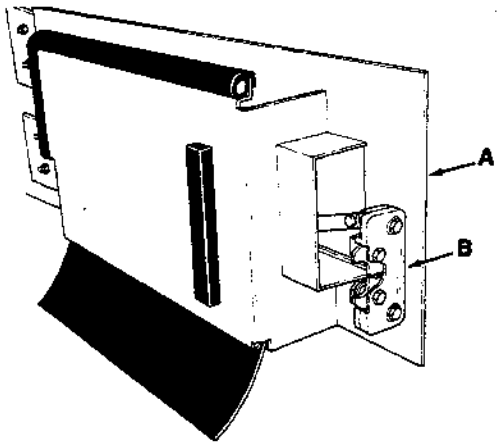


LATCH STRIKER 02164

A. Hopper Cover
B. Striker
C. Mounting Bracket

MAIN BRUSH DOOR LATCHES

The main brush door latches keep the main brush doors closed during normal machine operation. Pushing the latch lever up releases the latch. The latches can be lubricated with a dry lubricant. The latches are mounted in a fixed position. To adjust each door latching action, its latch strikers must be loosened, repositioned, and tightened.

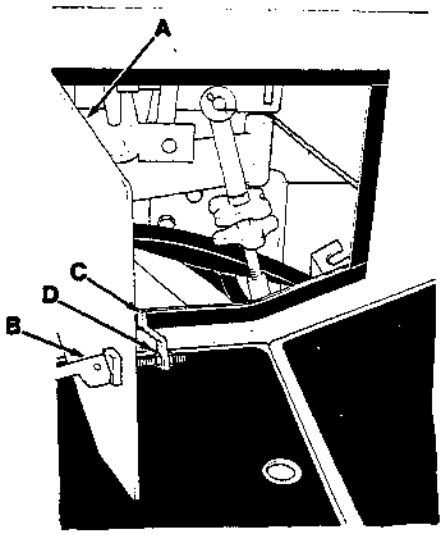


MAIN BRUSH DOOR LATCH 02162

A. Main Brush Door
B. Latch

ACCESS DOOR LATCH

The main brush height knob access door latch keeps the access door closed during normal machine operation. Pulling the latch handle out and rotating it releases the latch. To adjust the latch, loosen the latch tongue nuts. Thread them in or out to move the latch tonque and retighten the nuts.

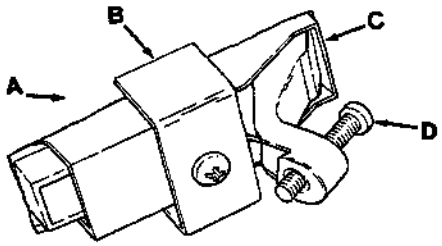


ACCESS DOOR LATCH 02150

A. Access Door
B. Latch
C. Latch Tongue
D. Tongue Nut

LEFT SIDE DOOR LATCH

The left side door latch keeps the door closed during normal machine operation. Pushing the latch button in releases the latch. To latch the door shut, the latch bar must be pressed flush with the door. To adjust the latch, thread the adjustment screw in or out until the latch closes with the door shut.



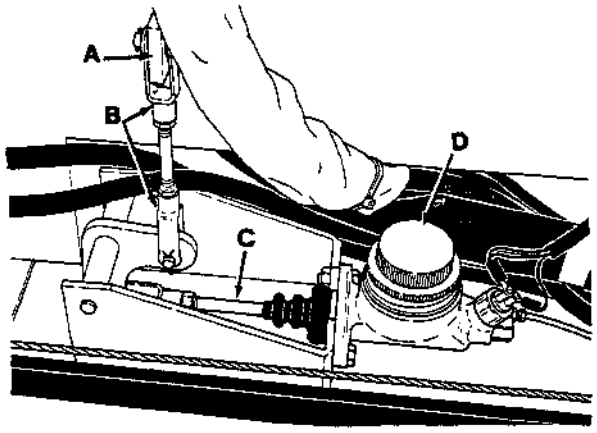
LEFT SIDE DOOR LATCH 00039

A. Left Side Door
B. Latch Retention Bracket
C. Latch
D. Adjustment Screw

SERVICE BRAKES

The service brakes are hydraulically activated by a master brake cylinder. Check the master brake cylinder fluid level after every 400 hours of operation and add brake fluid as needed. The master brake cylinder is located in front of the operator station. If, due to wear or replacement, the brakes need adjustment, an automotive-type tightening mechanism has been provided on each brake assembly. A mechanism is located behind a plugbutton on each side of the inner main frame.

If necessary, adjust the brake clevis on the master cylinder push rod so that the brake pedal is in a horizontal position when the cylinder push rod starts to engage the master cylinder piston.



BRAKE LINKAGE 02197

A. Brake Pedal
B. Brake Clevis
C. Master Cylinder Push Rod
D. Master Cylinder

Brakes require bleeding whenever air enters the system, lowering the effective braking pressure. Air can enter when the master cylinder or wheel cylinders are serviced or if the fluid in the reservoir runs dry. Air can also enter through a leaky brake line or hose. Find the leaking line and replace it before bleeding the system.

Whenever handling brake fluid, do not get any on the brake shoes, drums, or body paint. Brake pads will be permanently damaged, requiring replacement. Body paint can also be damaged unless the area is wiped with a clean cloth and washed with a soapy solution immediately.

TO BLEED THE BRAKES

1. Make sure that the brake fluid reservoir is full and that the vent in the cap is open.
2. Connect a plastic or rubber tube to the bleeder valve on the left front wheel. Suspend the other end of the tube in a jar or bottle filled with a few inches of brake fluid. During the remaining steps, keep this end submerged at all times and never let the level in the brake fluid reservoir drop below one half full.
3. Open the bleeder valve on the left front wheel about one turn. Have an assistant press the brake pedal slowly to the floor. As soon as the pedal is all the way down, close the bleeder valve and let the pedal up. Repeat this step as many times as necessary, until fluid free of air bubbles flows from the tube.
4. Bleed the right front wheel in the same manner as described in the steps above. Keep checking the brake fluid reservoir to be sure it doesn't run out of fluid.
5. When all wheels are bled, discard the brake fluid in the jar or bottle; never reuse such fluid.
6. Fill the brake fluid reservoir with clean fluid.

PARKING BRAKES

The parking brakes are mechanically activated by the parking brake lever and two cables.

The parking brakes should be adjusted whenever the machine rolls after engaging the parking brake, when it becomes very easy to engage the parking brake, and after every 200 hours of operation. The parking brake may be routinely tightened by turning the knurled knob on the end of the parking brake clockwise. If the knob adjustment is inadequate, fully loosen the knob, loosen the brake cable mounting nuts located under the operator seat, thread the lower nuts closer to the end of the cable, and retighten the top nuts. Be sure to thread each of the nuts out the same number of turns. Adjust the parking brake so it will hold the machine on a smooth 8° ramp.

TIRES

The standard front machine tires are pneumatic. The proper tire air pressure is 80 to 85 psi (550 to 590 kPa).

The standard rear machine tire is pneumatic. The proper tire air pressure is 50 to 55 psi (345 to 380 kPa). Check the air pressure of the tires after every 100 hours of operation.

Solid tires are available as accessories. No regular maintenance is required on these tires.

SECTION 4
APPENDIX

CONTENTS

HARDWARE INFORMATION

The following charts state torque ranges for normal assembly applications of standard plated hardware. Decrease the specified torque by 20% when using a thread lubricant. Do not substitute lower grade hardware for higher grade hardware. If higher grade hardware than specified is substituted, tighten only to the specified hardware torque value to avoid damaging the threads of the part being threaded into, as when threading into speed nuts or weldments.

STANDARD BOLT TORQUE CHART

Thread Size	SAE Grade 2 Torque ft lb (Nm)	SAE Grade 5 Torque ft lb (Nm)	SAE Grade 8 Torque ft lb (Nm)
0.25 in	5-6 (7-8)	7-10 (9-14)	10-13 (14-18)
0.31 in	9-12 (12-16)	15-20 (20-27)	20-26 (27-35)
0.38 in	16-21 (22-28)	27-35 (37-47)	36-47 (49-64)
0.44 in	26-34 (35-46)	43-56 (58-76)	53-76 (72-103)
0.50 in	39-51 (53-69)	65-85 (88-115)	89-116 (121-157)
0.62 in	80-104 (108-141)	130-170 (176-231)	117-265 (159-359)
0.75 in	129-168 (175-228)	215-280 (291-380)	313-407 (424-552)
1.00 in	258-335 (350-454)	500-650 (678-881)	757-984 (1026-1334)

NOTE: Decrease torque by 20% when using a thread lubricant.

Exceptions to the above chart:

Rear wheel hub nut - 200 to 250 ft lb (270 to 340 Nm)
Rear wheel lug nuts - 85 to 95 ft lb (115 to 130 Nm)
Vacuum fan impeller nut - 45 to 50 ft lb (60 to 70 Nm)

METRIC BOLT TORQUE CHART

Thread Size	Class 8.8 Torque ft lb (Nm)	Class 10.9 Torque ft lb (Nm)	Class 12.9 Torque ft lb (Nm)
M4	2 (3)	3 (5)	4 (6)
M5	4 (7)	6 (9)	7 (11)
M6	7 (11)	10 (16)	11 (19)
M8	18 (27)	25 (38)	29 (45)
M10	32 (53)	47 (74)	58 (87)
M12	58 (91)	83 (128)	100 (154)
M14	94 (145)	133 (204)	159 (244)
M16	144 (222)	196 (313)	235 (375)
M20	260 (434)	336 (610)	440 (732)
M24	470 (750)	664 (1050)	794 (1270)

NOTE: Decrease torque by 20% when using a thread lubricant.

BOLT IDENTIFICATION

Identification Grade Marking	Specification and Grade
	SAE-Grade 5
	SAE-Grade 8
	ISO-Grade 8.8
	ISO-Grade 12.9

01395

HYDRAULIC FITTING INFORMATION

HYDRAULIC TAPERED PIPE FITTING (NPT) TORQUE CHART

NOTE: Ratings listed are when using teflon thread seal.

Size	Minimum Torque	Maximum Torque
1/4 NPT	10 ft lb (14 Nm)	30 ft lb (41 Nm)
1/2 NPT	25 ft lb (34 Nm)	50 ft lb (68 Nm)
3/4 NPT	50 ft lb (68 Nm)	100 ft lb (136) Nm)

HYDRAULIC TAPERED SEAT FITTING (JIC) TORQUE CHART

Tube O.D. (in)	Thread Size	Maximum Torque
0.25	0.44"-20	9 ft lb (12 Nm)
0.38	0.56"-18	20 ft lb (27 Nm)
0.50	0.75"-16	30 ft lb (41 Nm)
0.62	0.88"-14	40 ft lb (54 Nm)
0.75	1.12"-12	70 ft lb (95 Nm)
1.0	1.31"-12	90 ft lb (122 Nm)

HYDRAULIC O-RING FITTING TORQUE CHART

Tube O.D. (in)	Thread Size	Minimum Torque	Maximum Torque
0.25	0.44"-20	6 ft lb (8 Nm)	9 ft lb (12 Nm)
0.38	0.56"-18	13 ft lb (18 Nm)	20 ft lb (27 Nm)
		*10 ft lb (14 Nm)	12 ft lb (16 Nm)
0.50	0.75"-16	20 ft lb (27 Nm)	30 ft lb (41 Nm)
		*21 ft lb (28 Nm)	24 ft lb (33 Nm)
0.62	0.88"-14	25 ft lb (34 Nm)	40 ft lb (54 Nm)
0.75	1.12"-12	45 ft lb (61 Nm)	70 ft lb (95 Nm)
1.0	1.31"-12	60 ft lb (81 Nm)	90 ft lb (122 Nm)

NOTE: Do not use sealant on o-ring threads.

*Aluminum bodied components