



MB Companies, Inc. MSV Multi Service Vehicle

Operation and Maintenance Manual



Hydraulic Power Broom Attachment for M-B Companies' Multi-Service Vehicle (MSV)

QUALITY YOU CAN SEE, PEOPLE YOU CAN TRUST™

Attachments Division, Brush Replacements, Administration

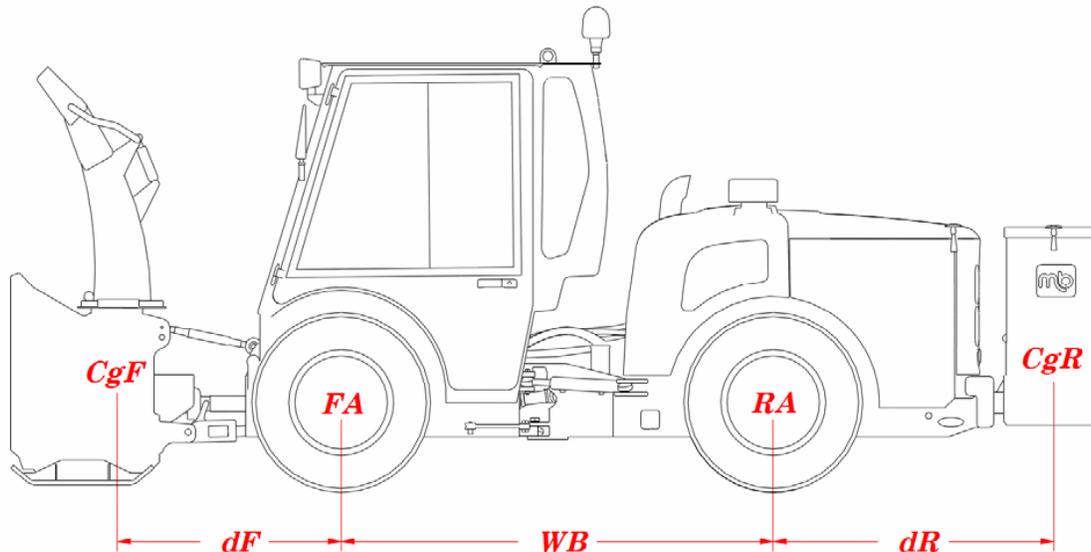
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Ballast Calculations

Adding Attachments will affect the stability, performance, characteristics, and reduces safe operating grades.

- Never exceed the max rating of the weakest component: GVWR, max axle ratings, or tire capacity.
- All calculations should be verified by weighing the MSV with the attachments on a certified scale.
- Attachments such as sanders and sprayers should be checked when filled with desired particulate.
- A scale must be used to determine axle weights when using a dump body.
- Ballast Types include: Fluid filled tires, wheel weights, or another attachment.
- Never operate with less than 25% of the total load on the front axle.

Caution: Whenever an attachment is mounted to the rear of the vehicle front ballast weight must be added.



CW= Curb Weight for MSV-100501; 6620, Front-2140 lbs, Rear-4480 lbs

TW =FA+RA including attachments and or ballast.

WB = Wheel Base; 81in for MSV

TFA= Total Front Axle Weight

TRA= Total Rear Axle Weight

CgF= Weight at the center of gravity of front attachment or ballast

CgR= Weight at the center of gravity of rear attachment or ballast

FA = Front Axle

RA = Rear Axle

dF = dimension from center of front axle to Center of gravity on front attachment or ballast

dR = dimension from center of rear axle to Center of gravity on rear attachment or ballast

$$TFA= \frac{[CgF \times (DF +WB) + (2140 \times WB) - (CgR \times dR)]}{WB}$$

$$TW= FA + RA$$

$$TRA= TW - TFA$$

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Safety

**WARNING:**

Read this manual and any attachment owner's manuals before using this equipment. Failure to do so can result in serious injury or death. Call your dealer if you have any questions.

HAZARD DEFINITIONS

For your safety, and to assure the long life of your equipment, be sure you understand the following signal words which will be seen throughout this manual:

- **DANGER:** Alerts you to an immediate hazard, which will always result in severe personal injury and possible death if it is not avoided.
- **WARNING:** Alerts you to a hazard which will result in a serious personal injury or possible death in some cases, if not avoided.
- **CAUTION:** Alerts you to a potential hazard which may result in a serious personal injury if not avoided. It also alerts against an unsafe practice that will permanently damage equipment or property.
- **IMPORTANT:** Points out a proper use that will avoid damage to the machine, and/or will extend the life of its parts.
- **NOTE:** Suggests how to use or adjust the equipment for best product results.

IDENTIFICATION OF SAFETY LABELS

Safety labels are strategically located around the attachment to prevent potential hazards. The labels are a permanent part of the equipment. If they become separated from the product or illegible, contact M-B Companies Inc. for no-cost replacements. Understand the information the labels are communicating before operating or maintaining the equipment.

See Parts List section for safety labels associated with this equipment.

GENERAL SAFETY

- This manual should be available during operation.
- Extra copies of this manual are available for purchase through the M-B Customer Service Department.
- To avoid serious injury or death, do not modify equipment. Any modifications made to equipment can be dangerous and can void equipment warranty.
- Never defeat a safety device to make a task easier.
- Never deface or remove factory-installed safety labels. If a label ever becomes lost, damaged, or illegible, report this condition to a supervisor and obtain a replacement label from the Customer Service department of M-B Companies, Inc.
- Always wear proper apparel when operating equipment; safety glasses, face shield or goggles, ear protection, and dust mask. Tie hair back. Never wear loose clothing or jewelry that could get caught in moving parts.
- Never operate equipment with covers or guards removed. Rotating parts can cause severe injury. Keep hands, feet, hair, jewelry and clothing away from all moving parts.
- Understand the operation of hydraulic and pneumatic controls.
- Understand which adjustments are operator and which are maintenance adjustments.
- Always shut OFF equipment when left unattended.
- Never operate or work around equipment if under the influence of alcohol, drugs or medications.

PRE-START-UP SAFETY

- Install any covers or guards which may have been removed for shipping purposes.
- Before starting equipment, walk around equipment, making a visual inspection that all safety devices are properly installed and secured.
- Check that all hardware, fasteners, hydraulic fittings, etc. are in good condition and properly fastened. Replace any fatigued or damaged items with proper replacements.
- Personnel who are not required to be in the work area should be kept away. Never start the equipment unless you are absolutely certain that everyone in the area is clear of the machine and aware it is being started.
- Follow the manufacturer's recommended start-up procedure.

PRESSURIZED SYSTEMS SAFETY

- Do not disassemble a pressurized system unless properly trained and equipped with adequate tooling.
- Familiarize yourself with the proper method of relieving pressure from pneumatic or hydraulic systems. Never perform maintenance on, or disassemble, pressurized systems without first locking out power to these systems and then relieving pressure to them.
- Oils and fluids can be very hot under pressure. Use caution and allow the system to cool before beginning maintenance work.
- Never operate or pressurize one of these systems with worn or damaged components. Replace hoses, fittings, valves or other components which appear defective.
- Never adjust pressurized systems beyond recommended levels to achieve higher operating pressures.

THE MANUAL

It is the purpose of this manual to provide complete instructions for service, maintenance disassembly, repair, and installation of the mechanical components for the M-B Multi-Service Vehicle Attachment.

Directional Reference

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

REQUIRED OPERATOR TRAINING

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

The Operator Must Understand:

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



WORK AREA

- ALWAYS check overhead and side clearances carefully before operation. ALWAYS be aware of traffic when operating along streets and curbs.
- Keep area of operation clear. Stay alert for hidden hazards.
- DO NOT run engine in an enclosed area. Always provide good ventilation.
- Abnormal Vibrations are a warning of trouble. Striking a foreign object can damage unit. Stop unit and engine. Wait for all moving parts to stop. Inspect unit and make any necessary repairs before restart.
- Protect eyes, face, and head from objects that may be thrown from unit. Wear appropriate hearing protection.
- Avoid Sharp Edges. Sharp edges can cause serious injury. Wear gloves to service unit when handling sharp edges.
- ALWAYS keep hands and feet away from all moving parts during operation. Moving parts can cause serious injury or death.
- Be aware of the surroundings. Look for blind spots from which pedestrians or vehicles may suddenly appear.
- Locate the emergency stop on the vehicle.
- Do not operate in crowded pedestrian areas. This equipment may cause serious injury or death if safety rules are not followed.
- The M-B Multiple Service Vehicle (M-B MSV) uses a level gauge. The gauge helps the operator determine the angle or slope of the surface being driven on. The gauge shows percent of grade.



WARNING:

During normal operation the M-B MSV must not exceed 30% grade to either side. Adding any attachment to the M-B MSV will affect the safe maximum grade.



Figure 1

MAINTENANCE SAFETY

- Do not remove guards while operating. After maintenance work, be sure all guards and other safety devices are installed and in proper working order.
- Never clean, lubricate, or adjust equipment while it is moving, has the potential to move or when engine is running.
- Always release pressure from pressurized systems before disassembling.
- Allow ample time for heated components to cool before working on or working close to them. Use temperature sticks or other appropriate devices to test temperatures.
- ALWAYS maintain unit in safe operation condition.
- Check the conditions of the unit at the end of each day and repair any damage or defects.
- Keep all fasteners properly torqued and in safe operating condition.
- Before maintenance, adjustments, or service (except where specifically recommended), shut off engine, and secure from moving.

Storage

ALWAYS clean and lubricate equipment before extended storage. Clean and lubricate equipment every 6 months during prolonged storage.

WELDING

Before welding on a machine/unit equipped with an electronic engine, the following precautions should be observed:

- Turn the engine control switch to the OFF position.
- Disconnect the negative battery cable at the battery. If a better disconnect switch is provided, open the switch.
- Connect the welder ground cable directly to the member to be welded. Place the ground cable clamp as close as possible to the weld to reduce the possibility of welding current damage to bearings, hydraulic components, electrical components and ground straps. Do not use electrical components, the ECM, or electronics ground stud for grounding of the welder.
- Protect wiring from welding debris or splatter.

General Information

INTRODUCTION

Thank you for choosing M-B Companies, Inc. as your equipment manufacturer and supplier. As part of our commitment to total customer satisfaction, we have strived to ensure that the information contained within this manual is complete and representative of the equipment you have purchased. The manual cannot, however, anticipate every possible contingency to be met in the installation, operation and maintenance for your equipment. If you require additional information not included in this manual, please contact our Service Department.

MACHINE IDENTIFICATION

Each machine manufactured by M-B Companies, Inc. has an identification plate mounted to it as shown in Figure 2. This plate contains the serial number of your M-B equipment. Copy the information from the plate on your equipment into the appropriate space in Figure 2. This information is important to have available when communicating with M-B.

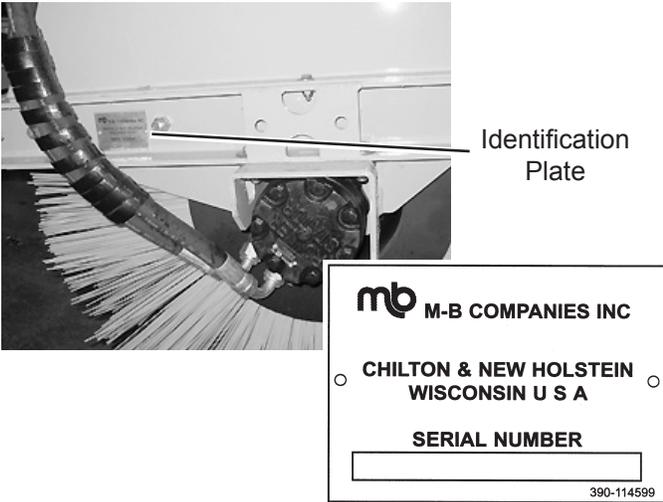


Figure 2

CUSTOMER SERVICE

The serial number on your equipment is essential for proper service support. When contacting M-B Companies regarding service support, always provide the product serial number. This number is located on the identification plate mounted on your equipment, and should also have been recorded in the Machine Identification section.

Customer Service Department
c/o M-B Companies, Inc.
1615 Wisconsin Ave.
PO Box 200
New Holstein, WI 53061
Phone: 1-888-558-5801 or 1-800-558-5800
Fax: 920-898-4588



Manufacturer's Limited Warranty

The M-B Companies, Inc. warrants all its M-B MSV products to be free from defects in materials and workmanship for 12 months, to begin with the delivery of said product to its original owner. This warranty is not transferable without the written consent of M-B.

M-B will, at its own expense and without expense to the owner, replace all failed parts for and make all repairs that may be required by reason of workmanship or material in any part of the assembly of the product and associated components.

Upon notice in writing, M-B will promptly repair or replace all defective or damaged items delivered under the contract. The batteries, tires, rubber materials, brushes and material normally consumed in operation, and major components such as engines, air compressors, and hydraulic pumps and motors are excluded from this warranty but shall, in any event, be guaranteed by M-B to the extent of any warranty received from its supplier.

Any components replaced under warranty will be warranted for the remainder of the original warranty. Replaced components do not restart the warranty period.

If requested by M-B, products or parts for which a warranty claim is made are to be returned, transportation prepaid, to M-B's factory. Any improper use, operation beyond capacity, or substitution of parts not approved by M-B, or alteration or repair by others in such a manner as in M-B's judgement materially and/or adversely affects the product shall void this warranty.

This warranty does not apply to defects caused by damage or unreasonable use while in the possession of the owner, including but not limited to: failure to provide reasonable and necessary maintenance, normal wear, routine tune-ups or adjustments, improper handling or accidents, operation at speed or load conditions contrary to published specifications, improper or insufficient lubrication, or improper storage.

The M-B Companies, Inc. shall not be liable for consequential damages of any kind, including, but not limited to, consequential labor costs or transportation charges in connection with the replacement or repair of defective parts, or lost time or expense which may have accrued because of said defect.

THE M-B COMPANIES DO NOT MAKE ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE. THE ONLY WARRANTY MADE BY M-B COMPANIES IS AS SET FORTH HEREIN. THIS WARRANTY CANNOT BE EXTENDED, BROADENED OR CHANGED EXCEPT IN WRITING BY AN AUTHORIZED OFFICER OF M-B COMPANIES, INC.

(M-B's total liability hereunder in no event shall exceed the purchase price of the product.)

Attachment Information

INTRODUCTION

This section provides information that is specific to the M-B Hydraulic Power Broom. Each sub-section describes a component or system to give the reader a reasonable understanding of the topic. If a more in-depth knowledge is needed, contact M-B Companies Customer Support.

SPECIFICATIONS

| Model | BR60 | BR72 | BR96 |
|---|-----------|-----------|-----------|
| Overall Width - in (cm) | 68 (172) | 80 (203) | 104 (264) |
| Length - in (cm) | 68 (172) | | |
| Operating weight - lbs (kg) | 820 (372) | 870 (395) | 970 (441) |
| Broom Diameter - in (cm) | 32 (81) | | |
| Path Cleared when Broom is Straight - in (cm) | 60 (152) | 72 (183) | 96 (244) |
| Path Cleared when Broom is at 30° Angle - in (cm) | 52 (132) | 62 (157) | 83 (211) |

DIMENSIONS

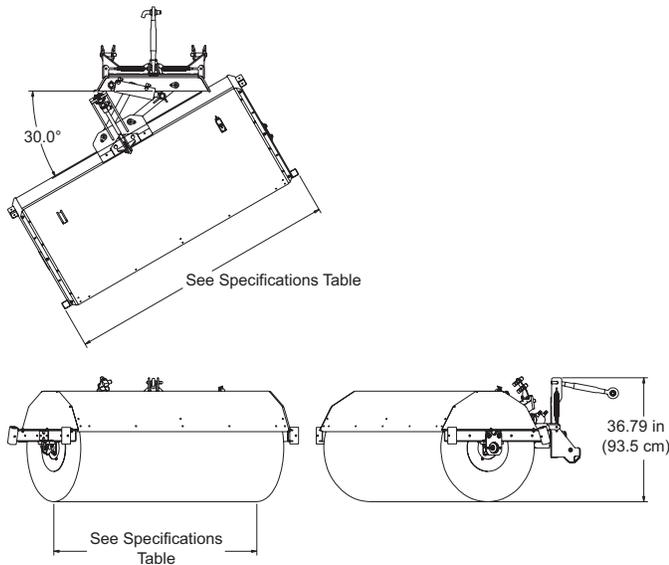


Figure 3

LAYOUT OF MACHINE

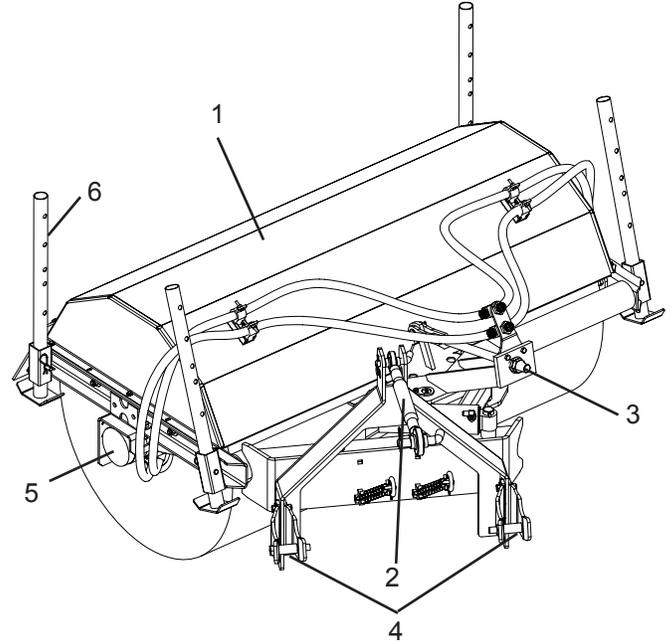


Figure 4

1. Hood
2. Top Adjust Link
3. Pattern Adjustment
4. Hitch Points
5. Broom Drive
6. Jack Stand



Operation

CONNECTING TO THE MSV

The Broom is connected to the M-B MSV by a three-point hitch. Hydraulic connections are used to position the Broom Head and drive the Broom.

Joystick Layout - Power Broom

The joystick layout screen in the attachment section of the MDC is used to display all the joystick functions when the Power Broom attachment is used. Use the Attachment Selection screen to change Default to Yes (Figure 5). The joystick functions will perform as shown in Figure 6.

If the Spreader and/or other rear attachments will also be mounted on the M-B MSV, other selections may be used. The joystick functions will perform as shown in Figure 7 through Figure 10.

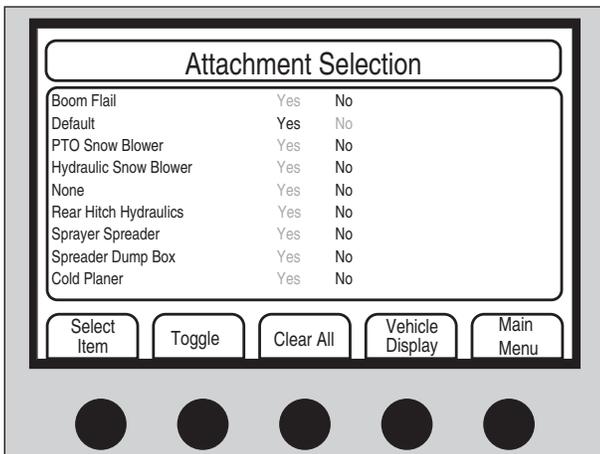


Figure 5

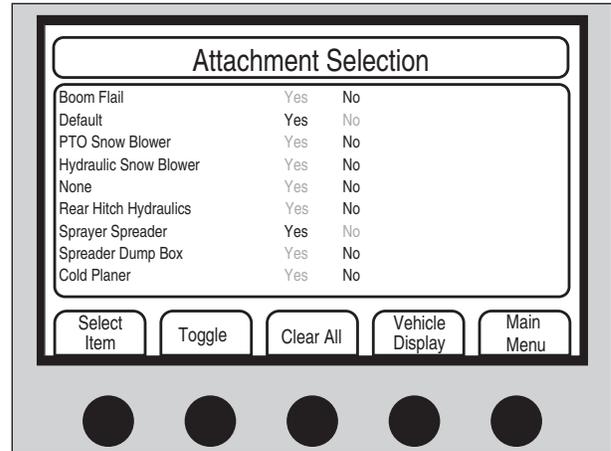


Figure 7

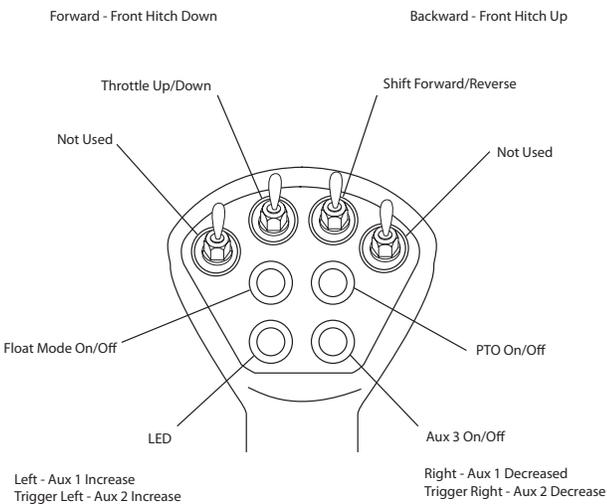


Figure 6

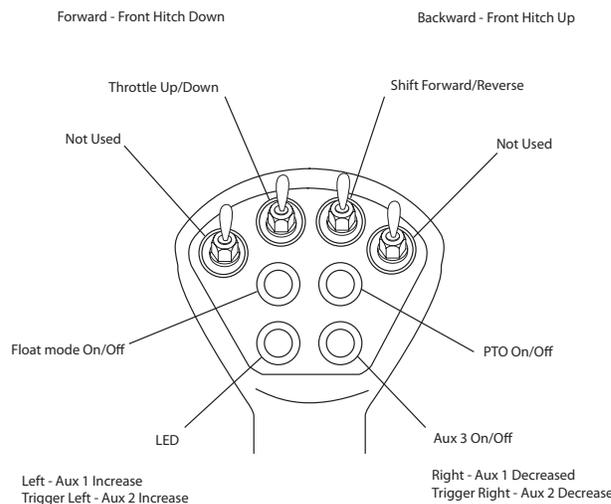


Figure 8

Use the Attachment Selection display, highlight Default and Rear Hitch Hydraulics. Toggle both to Yes.

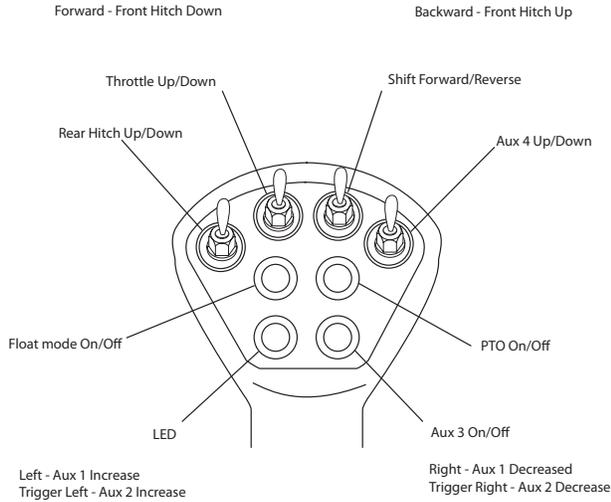


Figure 9

Use the Attachment Selection display, highlight Default and Sprayer Spreader. Toggle both to Yes.

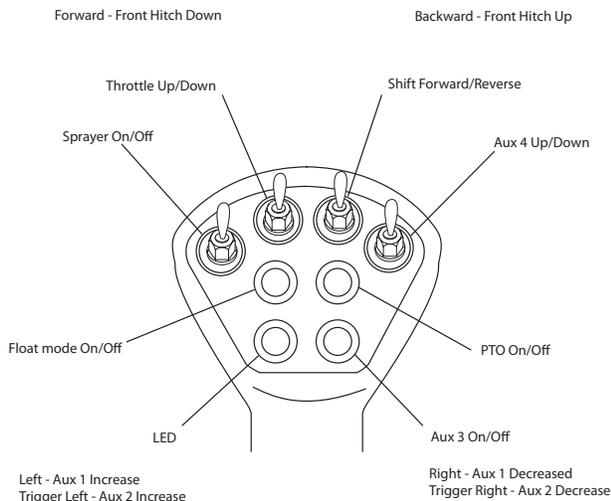


Figure 10

Connecting the Three-point Hitch

The M-B MSV front hitch has two clamps that lock to the two pins of the broom. Third mounting point is to the adjustable link.

Align the two M-B MSV front hitch clamps with the lower hitch points of the broom. The hitch hooks must be tightened and centered to the vehicle. Open the front hitch clamps by removing safety pin, moving hitch lock to the open position and inserting safety pin. Drive the M-B MSV forward to engage.

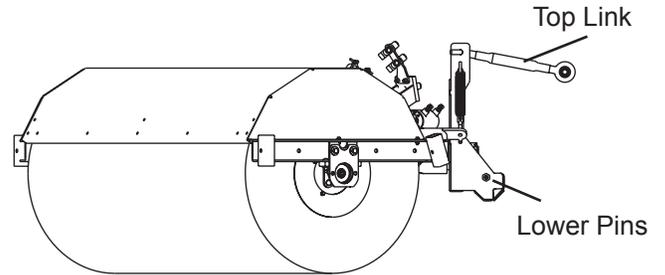


Figure 11

CAUTION:

⚠ If the broom is not centered on the vehicle damage may occur. Keep the hitch hooks tightened in place.

CAUTION:

⚠ The hydraulic hoses must be kept clear from all interference points.

MSV front hitch clamps may need to be raised or lowered to align properly. Pull back on joystick to raise front hitch clamps and push forward on joystick to lower.

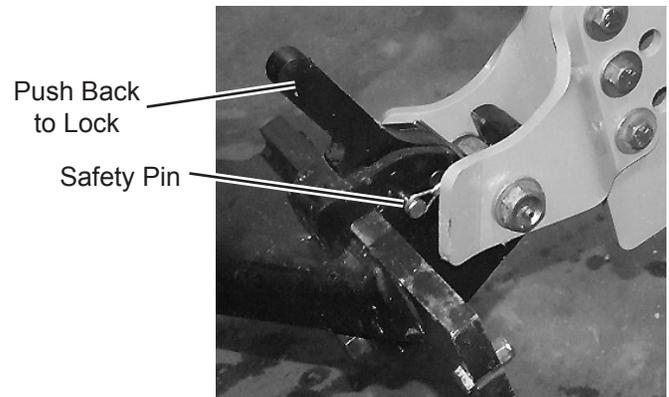


Figure 12



When the broom is properly aligned with the M-B MSV hitch clamps remove the safety pins, push back on the clamps to the lock position and use the appropriate pin and fasteners (Figure 12). Insert the safety pin.

Connect the top link to the M-B MSV hitch.

To attach top link it may be necessary to raise or lower the hitch using the joystick or by changing the top link length. Adjust the link length by turning it to shorten or lengthen.

When the top link is connected to the M-B MSV the broom attachment should be level. The top link is adjustable and is used to complete the leveling process.

To adjust the top link:

- Determine if the top link should get shorter or longer.
- Break loose the locking tab and screw it away from the body of the link.
- Screw the body of the link in or out as needed. A rod can be inserted into the hole in the body and used as a lever.
- Check the position of the attachment.
- Readjust as needed. Screw the locking tab against the link body. Strike the locking tab to force it into the body.

Attach Hydraulic Cylinder

The broom swing cylinder must be installed before using the broom (Figure 13).

1. Place the ends of the hydraulic cylinder over the two posts.
2. Insert cotter pins and spread.
3. Connect the hydraulic hoses. The hose with the female quick connect is connected to the rod end of the cylinder.

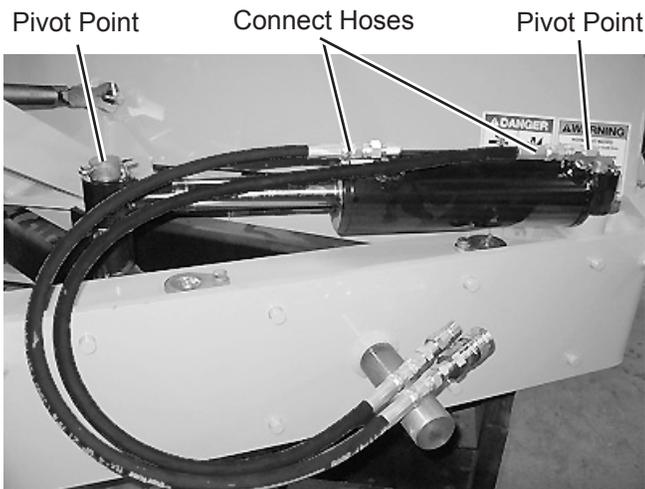


Figure 13

Connect Hydraulic Hoses

If this is the first installation 50" hose extensions may have to be installed. The pressure hose needs to be installed on the top port on the broom (Figure 14). Pressure hose is identified by the larger female quick disconnect (1-1/16") on the M-B MSV. Installation of hoses incorrectly will cause broom to rotate backwards.

Top Hose is Pressure

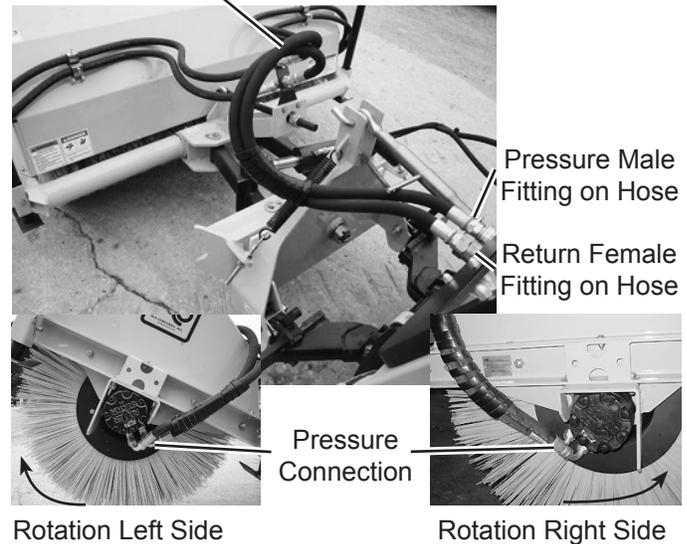


Figure 14

The front of the M-B MSV has several connections for hydraulic hoses. The M-B MSV operator manual has specifications for the quick disconnect fittings.

The controls in the M-B MSV cab will be setup to use the auxiliary connections. Connect the Broom to the appropriate connections. See Figure 15.

Broom Head position (swing) connects to Aux1.

The Broom drive connects to Aux 3.

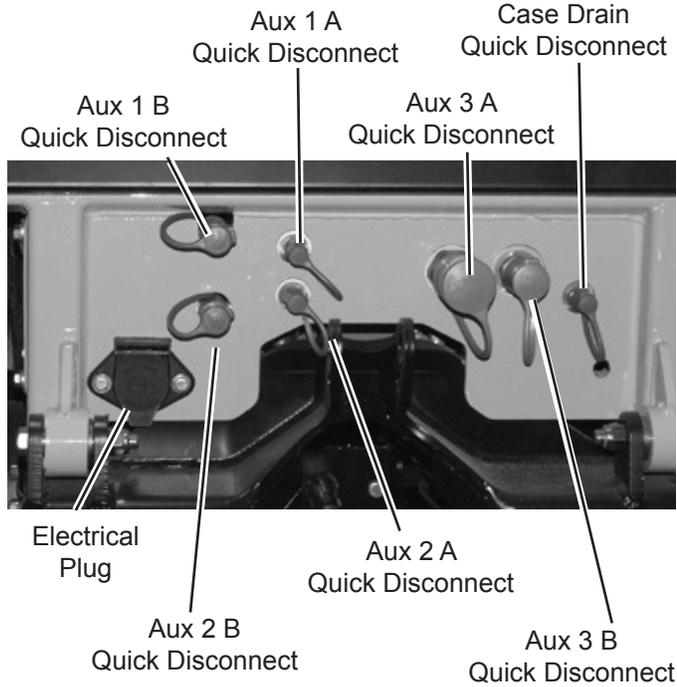


Figure 15

Deflector Assembly

Before using the broom attach the deflector (Figure 16).

1. Attach three vertical pieces with the top fastener. Do not tighten
2. Attach the lower horizontal bracket. Do not overtighten.
3. Install the rubber deflector and the horizontal support bracket.
4. Tighten all fasteners.

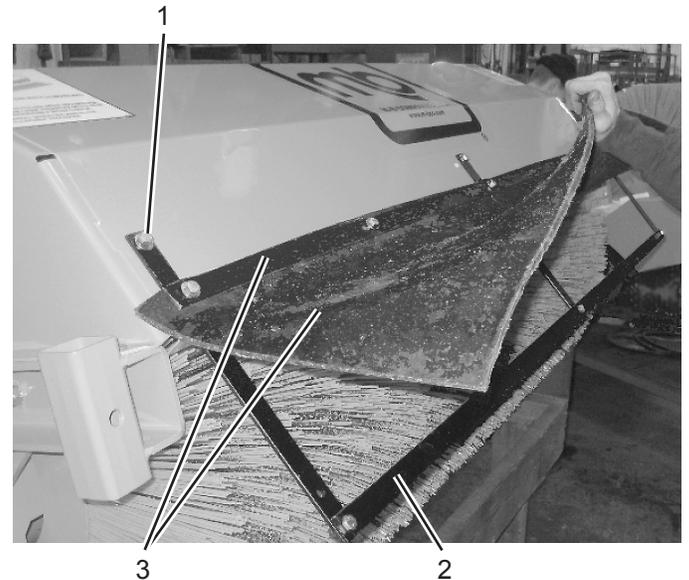


Figure 16

SETUP

Proper setup and leveling of your power broom will increase the life of the brush and produces more efficient movement of material. Visually inspect the adjustments on the broom before each operating session and measure the adjustments once every 10 hours.

The following procedures must be followed in the prescribed order in order to be effective.

Once the broom has been properly adjusted, a short operation period is recommended for break-in; approximately 15 minutes. After this break-in period repeat the leveling procedure to ensure that it is correct.



Leveling

After the broom is mounted to the M-B MSV, park the unit on a flat level surface; preferably concrete or asphalt.

1. Swing the broom so that it is straight in front of the M-B MSV.
2. Adjust down limit chains. You may need to remove chain links. Top of bathtub should be approximately 17 to 19 inches from ground depending on tires.
3. Adjust top link to make pivot arms parallel to ground.
4. Adjustment for brush pattern (4" recommended).
5. Compress spring to 5".

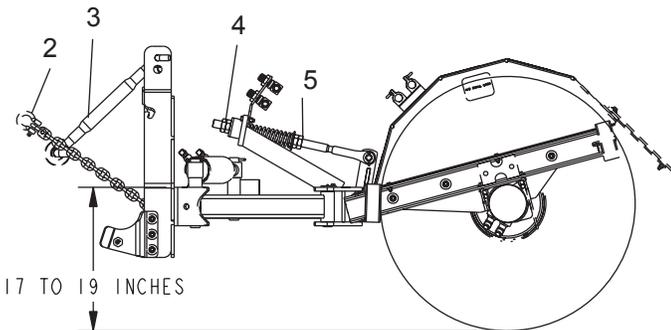


Figure 17

Pattern Adjustment

After the broom frame has been leveled, the last adjustment is to set the brush pattern. With the unit setup on a flat level surface adjust the nuts at the end of the anchor rod so that the bottom of the broom has approximately 3 inches of contact from the front-most contact point to rear-most contact point. Loosening the nuts will create more pattern. See Figure 17.

Once this adjustment is set, it can be confirmed by running the unit for about 30 seconds in the down position while stationary. Stop the broom and back the unit away. The 'cleaned' portion of the surface should be 2-4".

Pre-Startup Checks

1. Visually inspect equipment and hardware to ensure that all parts are secure and all hardware is tightened and secure.
2. Check for oil leaks and loose hose connections.
3. Inspect the broom adjustments to ensure that the broom is level and that there is proper brush pattern.
4. Inspect the bristle length to determine if replacement segments are needed.

OPERATION OF THE BROOM ATTACHMENT

Sweep at a speed that is appropriate for the conditions and location. For heavy material such as gravel or stones, drive more slowly with high broom speed. For lighter material, drive faster with lower broom speed. It may be necessary to increase broom pattern under some conditions. If the surface being swept is uneven and causes the broom to leave upswept patches, increase the pattern to compensate. If the material being swept is dried-on or difficult to remove such as mud or ice, it may be necessary to drive extremely slow to allow the broom to "scrub" the surface.

STARTING PROCEDURE

To start using the Broom:

- The M-B MSV should be running.
- The RPM of the engine must be less than 1250 RPM to engage the Broom.
- The M-B MSV needs to be in either work mode or crawl mode.
- The operator must have the seat belt on and PTO door closed.

The joystick will control Broom functions using Aux 1 and 3.

- Move joystick side-to-side to change angle of broom.
- Push joystick button Aux 3 to engage and disengage broom.
- Recommended broom speed is between 180-220 RPM's.

Broom speed is determined by aux pump size, flow settings and M-B MSV engine RPM.

Aux 3 flow can be manually adjusted withing the MDC (main menu/system hydraulics). Broom speed should be set as low as possible to reduce component wear and debris speed. Too high of a hydraulic flow may cause broom to slow down when steering. See the following chart for broom speeds.

Lower broom by pushing forward on joystick.

| | |
|---|-----------------|
| | CAUTION: |
| Do not use float mode with broom. M-B MSV broom does not have casters. The weight of the broom will cause excessive wear. | |

Lower as required to keep a 2-4" broom pattern.

Recommended broom speed is 180-220 RPM.

| M-B MSV RPM | Broom Speed | | |
|-------------|-----------------------------|-----------------------------|-------------------------------|
| | 31 gpm Aux Pump Max Setting | 26 gpm Aux Pump Max Setting | Either Aux Pump Set To 20 gpm |
| 1200 | 181 RPM | 152 RPM | 125 RPM |
| 1500 | 227 RPM | 190 RPM | 156 RPM |
| 2200 | 333 RPM | 278 RPM | 229 RPM |
| 2700 | 409 RPM | 341 RPM | 281 RPM |

STORAGE

Always store the broom in a supported position with the bristles off the ground. If the bristles are stored in a deformed position for extended periods of time the broom will become severely out of balance. Store the broom in a location out of the sun and weather to prevent premature failure of plastic bristles. Bristles can become brittle when subjected to sunlight or repeated temperature changes.

Properly clean the unit before storage and remove dirt, debris, salt, etc. to extend paint life. If the unit is power-washed, all lubrication points should be greased before storage.

| | |
|--|-----------------|
| | WARNING: |
| Fluid escaping under pressure can puncture the skin and cause serious injury. Do not touch any hydraulic components until the tractor engine has been turned off and hydraulics disconnected. Before startup, check for loose hydraulic connections. | |
| Fluid accidentally injected into the skin must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result. | |
| Make sure all hydraulic fluid hoses and lines are in good condition and all hydraulic connections and fittings are tight before applying pressure to the system. | |
| Keep body and hands away from pinhole leaks or nozzles that eject high pressure hydraulic fluid. | |
| Use cardboard or paper, not your hands, to find hydraulic leaks. | |
| Safely relieve all pressure in the hydraulic system by placing the motion control pedals/ levers in neutral and shutting off the engine before performing any work on the hydraulic system. | |

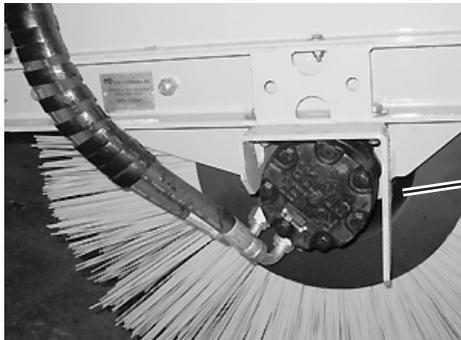
LUBRICATION POINTS

General Lubrication

Grease all lubrication points per the maintenance schedule using Chevron Ultra Duty II, Grade 2; or equivalent high-temp grease.

LUBRICATION CHART

| Locations Refer to Figure 18 | Number of Locations | Before Each Use | Frequency | | | | Lubrication Type | | |
|--|---------------------|-----------------|-----------------------------|-------|--------|---------|------------------|--|------------------|
| | | | Every 10 hours of operation | Daily | Weekly | Monthly | Annually | Chevron Ultra Duty II Grade 2 or equivalent high-temp grease | Chain Lube Spray |
| 1. Swing Arms | 4 | | x | | | | | x | |
| 2. Pivot Points | 2 | | x | | | | | x | |
| 3. Hitch Pins | 2 | | x | | | | | x | |
| 4. Motor Bearings | 2 | | x | | | | | x | |
| All other moving joints and pins (Do not lubricate oscillation bearings) | | | x | | | | | | x |



4
Motor Bearing
Grease Fitting

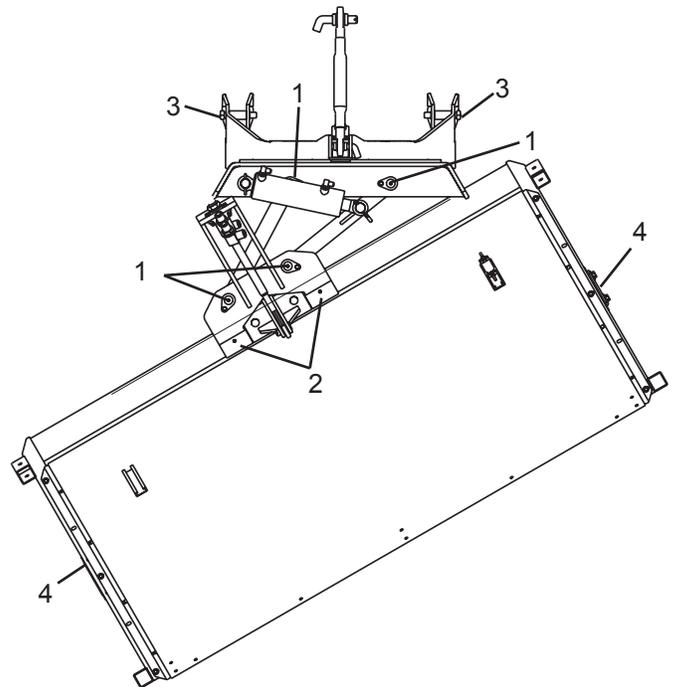


Figure 18



WAFER REPLACEMENT

1. Lower broom until the brush contacts the ground.
2. Remove the hood. Disconnect the hose clamps to loosen the hydraulic hoses (Figure 19). Remove the fasteners on each side. Lift the hood off.

Hood Fasteners

Hose Clamps



Figure 19

NOTE: When removing or changing the broom it may not be necessary to disconnect the hydraulic hoses from the motors.

3. Disconnect the hydraulic hoses to both motors.



CAUTION:

Some hydraulic fluid will drain from the hoses. Use a drip pan under the connections.

4. Support the frame and remove the fasteners that hold the motor bracket to the frame (Figure 20).

Lift Point Fasteners for motor bracket



Hydraulic Connection

Figure 20

5. The frame has a lift point that can be used to help lift the frame off of the broom.
6. When the frame has been lifted far enough to expose the motor brackets the motors with brackets may be pulled out.
7. Stand the broom on end. Remove the retaining plate (Figure 21).

Retaining Plate

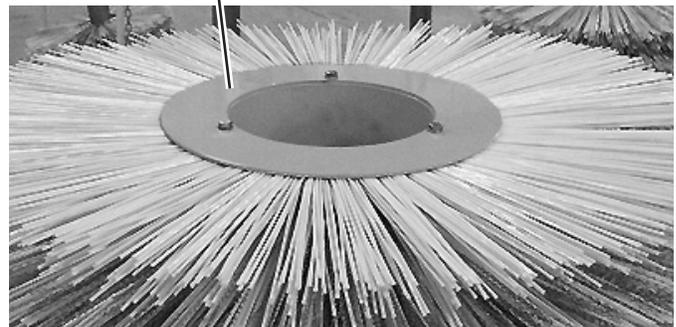


Figure 21

8. Remove all of the worn segments. When the core is empty inspect it for damage. Repair if necessary. Clean any sand or debris. To place new wafers on the core, stand the core on end.
9. Place a, poly only, wafer onto the core. Follow with a spacer ring (Figure 22).

First Wafer (Poly only) Spacer Ring



Figure 22

NOTE: Each wafer has a locating pin. When placing the wafers on the core the pins must stagger by 120 degrees. This will maintain balance of the rotating broom.

10. Install the second wafer. The locating pin must be staggered by 120 degrees from the first wafer.
11. Add a spacer followed by the next wafer. Continue adding spacers and wafers. Figure 23 shows the staggered locating pins. When the top of the core is reached the last wafer must be a solid poly wafer (Figure 24). When the retaining ring is put in place and bolted down, the stack of wafers will compress.



Second Wafer's
Locating Pin

First Wafer's
Locating Pin

Figure 23

Solid Poly Ring
Spacer Ring
Poly/Wire Wafer
Spacer Ring



Figure 24

12. Place the retainer plate in position (Figure 25). Tighten bolts compressing the wafers.

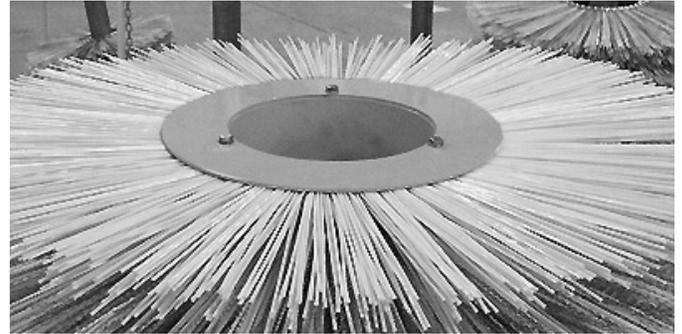


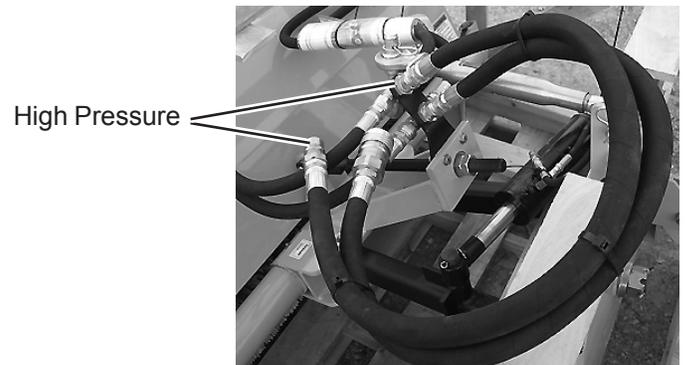
Figure 25

13. Lay the broom on it's side.

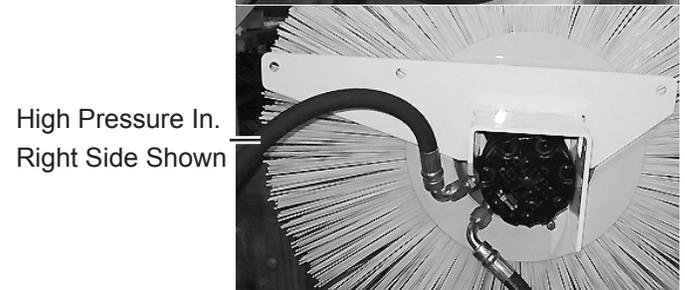
NOTE: Apply grease or anti-seize to splines before installing hydraulic motors.

14. Push the drive motors into the splined ends of the broom.
15. Use a lifting device to raise the frame up. Move the broom under the frame.
16. Lower the frame (do not pinch hydraulic hoses) over the motor brackets.
17. Fasten the motor brackets to the frame. If the hydraulic hoses were removed, reattach them.

NOTE: The high pressure hose must be attached to the inlet on the motor (Figure 26).



High Pressure



High Pressure In.
Right Side Shown

Figure 26



18. Position the hood and bolt in place. Reclamp the hydraulic hoses. Before placing machine back in service, adjust and test for proper brush pattern. Excessive pattern can cause brush failure or premature wear.

CHANGING DRIVE MOTOR

Removing the broom drive motors for service or replacement requires that the broom be removed from the frame. Refer to the section Wafer Replacement.



WARNING:

All hydraulic lines to the M-B MSV must be disconnected.

1. Label the two hydraulic lines at the motor to aid with reassembly.
2. Disconnect the hydraulic lines at the motor.

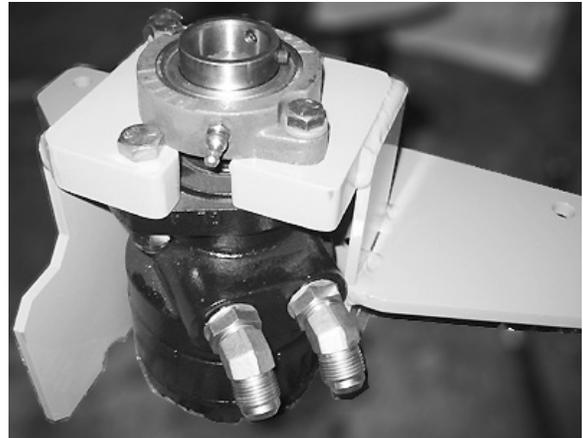


CAUTION:

Use a catch pan to contain fluid that will leak.

3. Proceed with removing the brush as described in Wafer Replacement.
4. After the motor bracket is unbolted and the frame is lifted, pull out on the motor and frame. Before disassembly make note of the grease fittings, the position of the bearings and the hydraulic fittings (Figure 27).

Right



Left

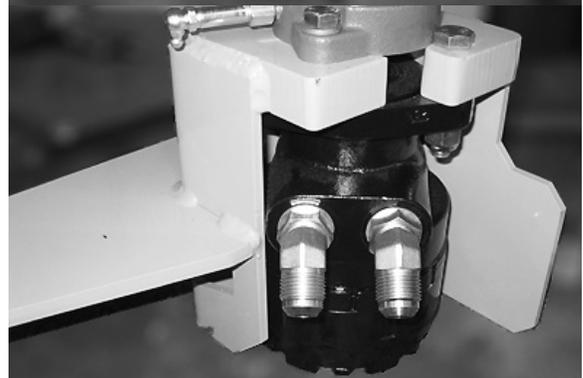
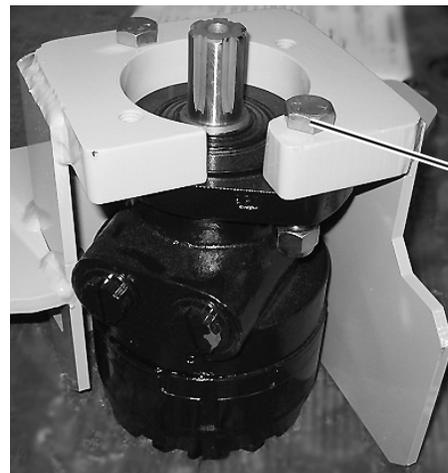


Figure 27

5. Disassemble and clean/replace parts as needed.
6. To assemble place the motor in position. The left side is shown (Figure 28).



Bolts through unthreaded holes

Figure 28

7. Insert bolt. The lock washer with nut should be finger tight.
8. Assemble grease fitting to bearing.

9. Place bearing in position (Figure 29). Insert a hub into the bearing and over the spline shaft of the motor. This step aligns the bearing. If the hub is not used it may be difficult to attach the assembly to the brush core.
10. Tighten bolts while checking the rotation of the hub. When fasteners are tight the hub must rotate without binding.

NOTE: Tapping the hub with a rubber mallet may aid with the assembly.

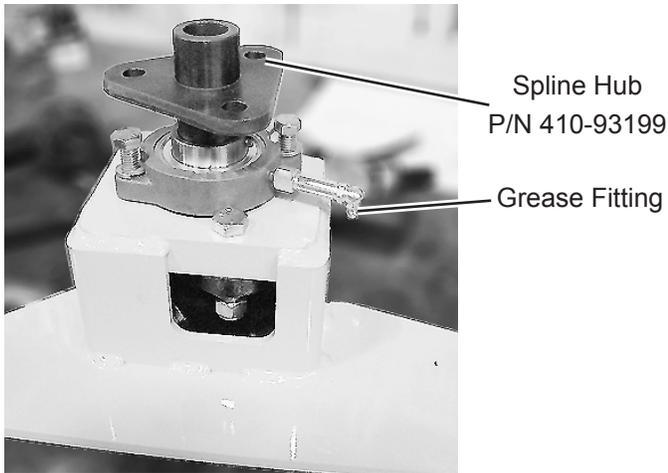


Figure 29

11. Attach hydraulic fittings as shown in Figure 27.
12. Remove hub and grease the fitting. The motor with bracket can be placed on the core and the brush assembled to the frame. Refer to the section Wafer Replacement.



Troubleshooting

OPERATION

| Problem | Probable Cause | Corrective Action |
|------------------------------|--|------------------------------------|
| Broom does not rotate | No hydraulic pressure/flow | Check tractor operation |
| | Hoses disconnected | Connect hoses and fittings |
| | Hoses bent or kinked | Remove sharp bends and kinks |
| | Pressure relieving to low | Adjust relief valve |
| | Electric valve not functioning | Check electrical connections |
| Bristles wearing unevenly | Swing arms out of adjustment | Adjust using bolts on rear |
| | Broom head not level | Adjust using leveling bolt |
| | Pattern adjustment not set | Adjust on head anchor |
| Broom sweeping poorly | Material is 'caked-on' or frozen | Slow down and 'scrub' surface |
| | Uneven sweeping surface | Increase pattern to compensate |
| | Material is too heavy | Slow down tractor speed |
| | Broom rotating too slowly | Increase engine speed |
| | Tractor moving too fast | Slow down tractor speed |
| | Pattern adjustment not set | Adjust at head anchor |
| Broom does not lift or angle | No hydraulic pressure/flow | Check tractor operation |
| | Electric valve not functioning | Check electrical connections |
| | System backpressure | Check tractor manual |
| Pump making noise | Pump intake blocked | Check inlet lines for obstructions |
| | Shaft seal leaking | Check and repair as necessary |
| Broom rotates backwards | 50" hose extension installed to wrong connection | Change hose connections |
| | Broom drive hoses installed to wrong pump connection | Change hose connections |

Replacement Parts

REPLACEMENT PARTS



390-118352



390-118354



390-140501



390-118355



390-118353



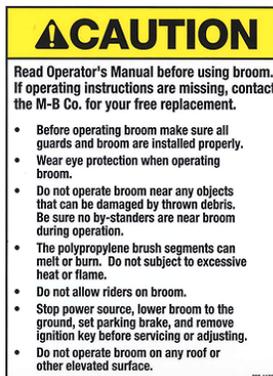
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390-118356



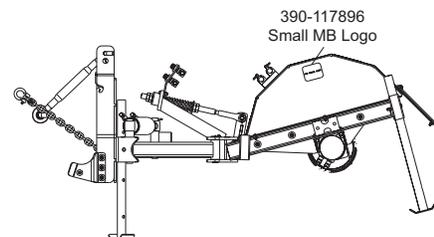
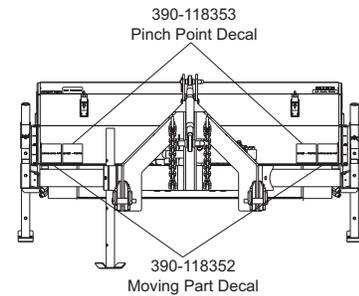
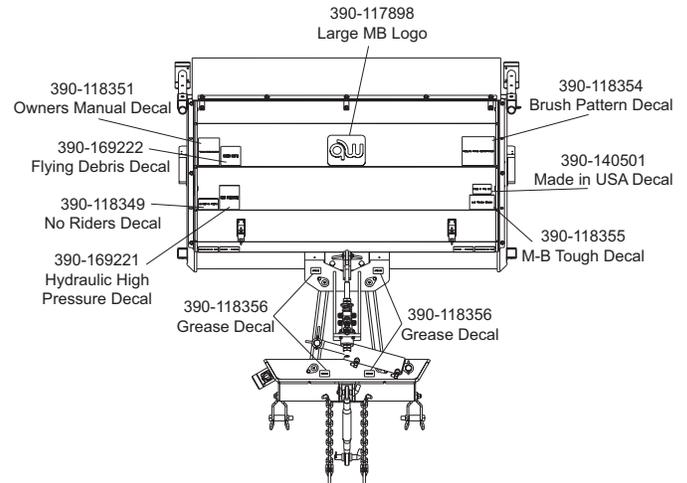
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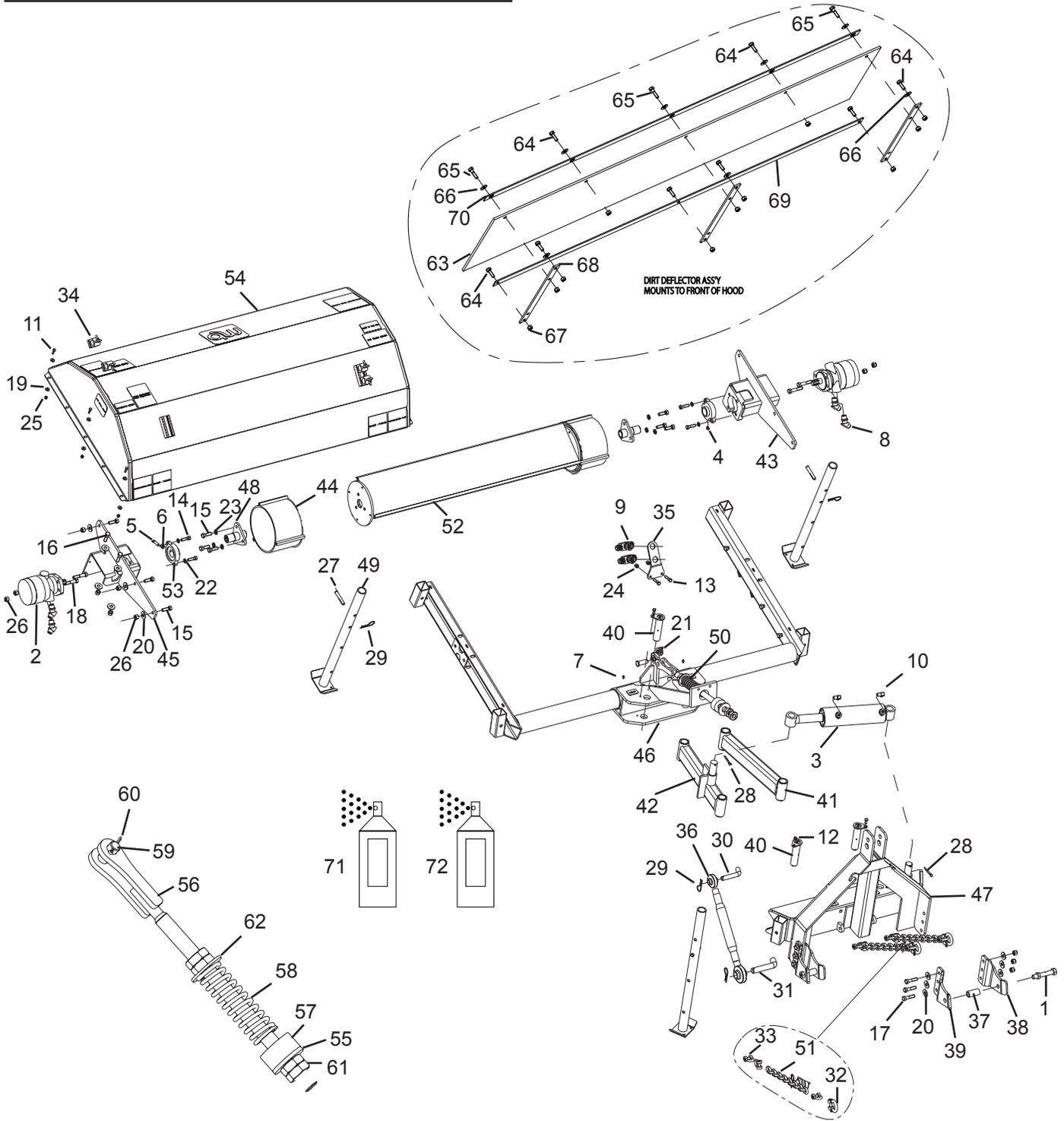


390-169221





HL HT



| Replacement Parts List | | | |
|------------------------|-------------|--|-----|
| Item | Part Number | Description | QTY |
| 1 | 100-157398 | Pin, 3/4" x 4-1/4" w/Zirk and Locknut | 2 |
| 2 | 201-75209 | Motor, Hydraulic 18.3 CU IN | 2 |
| 3 | 203-72277 | Hydraulic Cylinder | 1 |
| 4 | 206-140041 | Grease Zerk 1/4-28, 45° | 1 |
| 5 | 206-140051 | Grease Zerk 1/8 NPT, 90°, Long | 1 |
| 6 | 206-140052 | Adapter, Grease 1/4-28 Male x 1/8 NPTF | 1 |
| 7 | 206-72100 | Grease Zerk 1/4-28 | 2 |
| 8 | 211-132797 | Elbow, 45, ORBM x JICM 7/8 x 7/8 | 4 |
| 9 | 211-64563 | Bulkhead Tee 1-1/16 JIC | 2 |
| 10 | 211-71943 | Elbow 90, ORB x JIC 9/16 JIC x 7/16 ORB | 2 |
| 11 | 311-11000 | HHCS .25-20 UNC x 1.000 | 6 |
| 12 | 311-20750 | HHCS .31-18 UNC x 0.750 | 4 |
| 13 | 311-31500 | HHCS 3/8-16 UNC x 1.500 | 2 |
| 14 | 311-41500 | HHCS .44-14 UNC x 1.500 | 4 |
| 15 | 311-51500 | HHCS .50-13 UNC x 1.500 | 12 |
| 16 | 311-51750 | HHCS .50-13 UNC x 1.750 | 4 |
| 17 | 311-52000 | HHCS .50-13 UNC x 2.000 | 6 |
| 18 | 311-52500 | HHCS .50-13 UNC x 2.500 | 4 |
| 19 | 341-10000 | Washer, Flat - 1/4 STD Zinc PL | 12 |
| 20 | 341-50000 | Washer, Flat - 1/2 STD Zinc PL | 26 |
| 21 | 343-80000 | Washer, SAE 3/4 | 3 |
| 22 | 351-40000 | Washer, Lock - 7/16 YLW Zinc PL | 4 |
| 23 | 351-50000 | Washer, Lock - 1/2 YLW Zinc PL | 6 |
| 24 | 371-81297 | Nut, Hex, ESNA, 3/8-16 UNC | 2 |
| 25 | 371-81299 | Nut, Hex, ESNA, 1/4-20 NC | 6 |
| 26 | 371-81417 | Nut, Hex, ESNA, 1/2-13-UNC | 20 |
| 27 | 380-76379 | Pin, Clevis 1/2 x 3.0 | 3 |
| 28 | 380-83943 | Pin, Cotter | 2 |
| 29 | 380-84739 | Pin, Hair Clip #11 | 5 |
| 30 | 383-122610 | Pin, Hitch, Bent Pull 3/4 x 3-1/2 Grip LGA | 1 |
| 31 | 383-132433 | Pin, Hitch Bent 1 x 4-3/4 Grip LG | 1 |
| 32 | 385-163027 | Shackle, Screw-Pin 1/2 IN, 6600LB Limit | 2 |
| 33 | 385-83526 | Shackle, Chain 3/8" DIA | 6 |
| 34 | 387-132522 | Clamp Assy 1.00 | 4 |
| 35 | 401-132409 | Plate, Bulkhead Anchor | 1 |
| 36 | 401-152698 | Top Link, MAV CAT 1 & 2, 12" Body | 1 |
| 37 | 401-157399 | Tube, Spacer | 2 |
| 38 | 401-157585 | Plate, Hitch, Left Attachment | 2 |
| 39 | 401-157586 | Plate, Hitch, Right MSV, Attachment | 2 |



| Replacement Parts List | | | |
|------------------------|-------------|---------------------------------------|-----|
| Item | Part Number | Description | QTY |
| 40 | 410-132762 | Pin, WU, Swing | 4 |
| 41 | 410-132773 | Arm, R.H. - WU | 1 |
| 42 | 410-132774 | Arm, L.H. - WU w/Pin | 1 |
| 43 | 410-140029 | Bracket, Motor MTG RH | 1 |
| 44 | 410-140038 | Core Extension, W.U. | 2 |
| 45 | 410-140049 | Bracket, Motor MTG LH | 1 |
| 46 | See Table 1 | Frame, Brush HT/HL | 1 |
| 47 | 410-157391 | Pivot Frame WU | 1 |
| 48 | 410-93199 | Spline Hub 3.5" B.C. | 2 |
| 49 | 410-94050 | Storage Stand W.U. | 3 |
| 50 | 430-97799 | Head Anchor Assembly, HL, W/Dampeners | 1 |
| 51 | 509-163028 | Chain, Alloy 3/8 x 15 Links | 2 |
| 52 | See Table 1 | Core, Tri | 1 |
| 53 | 600-90327 | Bearing, Ball 1.438 ID 2 Bolt Flange | 2 |
| 54 | See Table 1 | Broom Hood WU | 1 |
| 55 | 401-162510 | Washer 1.1" ID, 2.5" OD x .25 | 1 |
| 56 | 400-33137 | Anchor Rod WU Broom Head | 1 |
| 57 | 388-176950 | Damper, Head Anchor Urethane | 1 |
| 58 | 382-176881 | Spring, Compression, 6" 1.937 OD | 1 |
| 59 | 380-92043 | Pin, CLevis, 3/4 IN DIA | 1 |
| 60 | 380-91744 | Pin, Cotter | 1 |
| 61 | 371-90291 | Nut, Hex Jam UNC 1-8 Unc Jam | 4 |
| 62 | 341-97100 | Washer, Flat I STD Zinc PL | 1 |
| 63 | See Table 1 | Dirt Deflector | 1 |
| 64 | 311-21000 | HHCS .31-18 UNC x 1.000 | 8 |
| 65 | 311-21250 | HHCS .31-18 UNC x 1.250 | 3 |
| 66 | 341-20000 | Washer, Flat - 5/16 STD Zinc PI | 8 |
| 67 | 371-81620 | Nut, Hex, ESNA, 5/16-18 UNC | 11 |
| 68 | 400-83533 | Strip, Deflector Support HT/HL | 3 |
| 69 | See Table 1 | Strap Support | 1 |
| 70 | See Table 1 | Strap Retainer | 1 |
| 71 | 109-131128 | Yellow Touch-up Paint | |
| 72 | 249-92005 | Primer, Aerosol Can | |

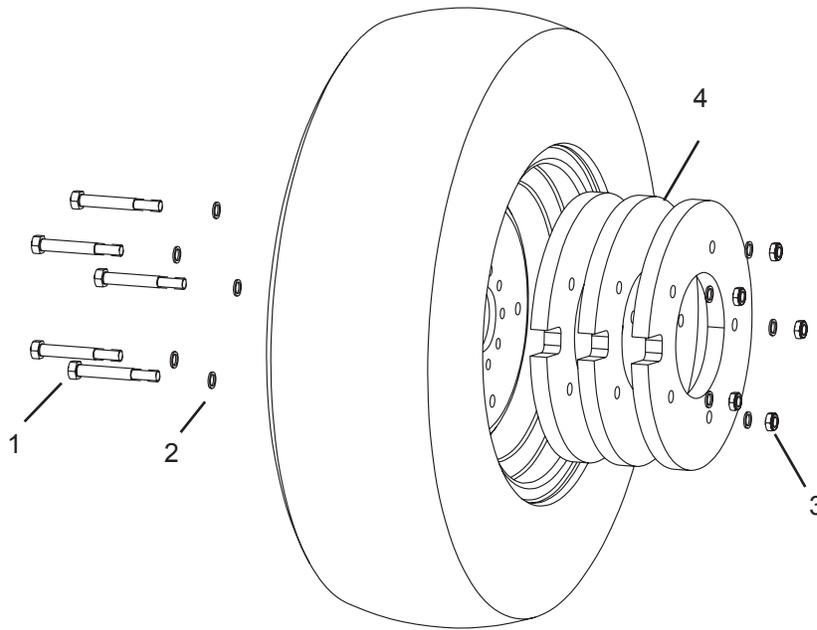
Table 1:

| | Deflector | Strap, Support | Strap, Retainer | Core | Frame | Hood |
|----|-----------|----------------|-----------------|------------|------------|------------|
| 4' | 101-92031 | 403-00038 | 403-00039 | 410-132030 | 410-176210 | 410-143271 |
| 5' | 101-92038 | 402-92961 | 402-92963 | 410-93192 | 410-132766 | 410-93146 |
| 6' | 101-92039 | 402-92962 | 402-92964 | 410-93193 | 410-132767 | 400-91134 |
| 8' | 101-75791 | 400-83532 | 400-62502 | 410-93195 | 410-132769 | 400-91132 |

Table 2:

| | Brush Refill Kit | Brush Refill Kit Contents | | |
|----|------------------|---------------------------|------------------------------|---------------------|
| | | Poly Wafer 101-22891 | Poly Wire Wafer 101-92105 | Spacer 402-93219 |
| 4' | 430-96713 | 2 | 26 | 27 |
| 5' | 430-92076 | 2 | 34 | 35 |
| 6' | 430-92079 | 2 | 38 | 39 |
| 8' | 430-92085 | 2 | 52 | 52 |

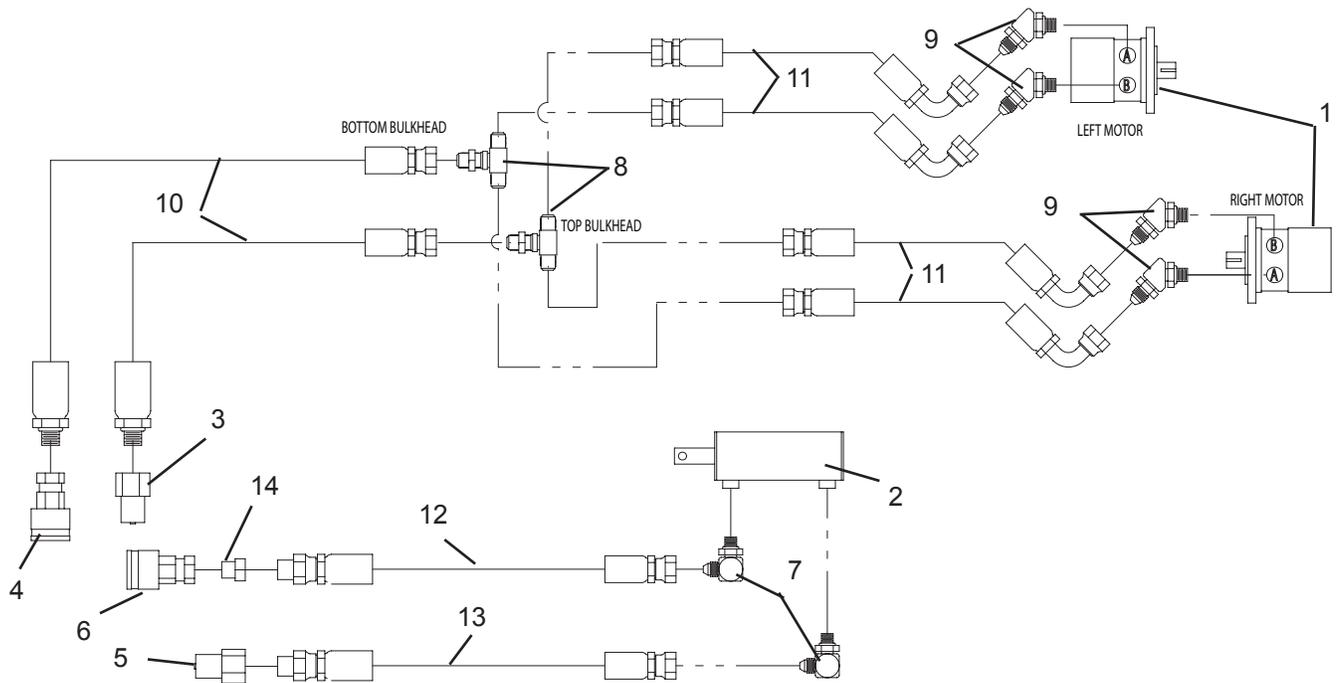
WHEEL WEIGHTS (OPTIONAL)



| Replacement Parts List | | | |
|------------------------|-------------|------------------------------|-----|
| Item | Part Number | Description | QTY |
| 1 | 311-74750 | HHCS .625-11 UNC x 4.750 | 10 |
| 2 | 343-70000 | Washer, SAE 5/8 | 20 |
| 3 | 371-97104 | Nut, Hex ESNA Jam 5/8-11 UNC | 10 |
| 4 | 401-163645 | Wheel Weight, MSV | 6 |



HL HT HYDRAULIC



Replacement Parts List

| Item | Part Number | Description | QTY |
|------|-------------|--------------------------------|-----|
| 1 | 201-75209 | Motor, Hydraulic | 2 |
| 2 | 203-72277 | Cylinder, Swing | 1 |
| 3 | 207-144670 | QD, 1-1/16 ORB Male | 1 |
| 4 | 207-144672 | QD, 1-16 ORB Female | 1 |
| 5 | 207-157736 | QD, 1/4 F NPT, Male Nipple | 2 |
| 6 | 207-157737 | QD, 1/4 F NPT, Female Coupler | 1 |
| 7 | 211-71943 | Elbow 90 7/16 ORBM x 9/16 JICM | 2 |
| 8 | 211-64563 | Bulkhead Tee 1-1/16 JIC | 2 |
| 9 | 211-132797 | Elbow, 45m 7/8 ORB x 7/8 JIC | 4 |
| 10 | 213-152966 | Hose Assy, 3/4 x 50" | 2 |
| 11 | See Table 3 | Hose Assy, 5/8 x ### | 4 |
| 12 | 213-157853 | Hose Assy, 1/4 x 39" | 1 |
| 13 | 213-157855 | Hose Assy, 1/4 x 33" | 1 |
| 14 | 211-92106 | Orifice, 1/4 NPT, Drill 1/32 | 1 |

Table 3:

| Broom | Item 11 | Hose Length |
|-------|------------|-------------|
| 4' | 213-175211 | 62" |
| 5' | 213-157605 | 68" |
| 6' | 213-163029 | 74" |
| 8' | 213-163030 | 86" |



HYDRAULIC FITTING INSTALLATION TORQUE RECOMMENDATION

Table 4: For 37° & 45° (Machined or Flared) and MegaSeal®

| Size | | Steel | | | | Brass | | | |
|------|------------------|---------|------|---------------|------|---------|------|---------------|------|
| Dash | Fractional (In.) | Ft-Lbs. | | Newton-Meters | | Ft-Lbs. | | Newton-Meters | |
| | | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. |
| -4 | 1/4 | 10 | 11 | 13 | 15 | 5 | 6 | 6-3/4 | 9 |
| -5 | 5/16 | 13 | 15 | 18 | 20 | 7 | 9 | 10 | 13 |
| -6 | 3/8 | 17 | 19 | 23 | 26 | 12 | 15 | 17 | 20 |
| -8 | 1/2 | 34 | 38 | 47 | 52 | 20 | 24 | 27-2/3 | 33 |
| -10 | 5/8 | 50 | 56 | 69 | 76 | 34 | 40 | 46-1/3 | 55 |
| -12 | 3/4 | 70 | 78 | 96 | 106 | 53 | 60 | 72-1/3 | 82 |
| -16 | 1 | 94 | 104 | 127 | 141 | 74 | 82 | 100-1/2 | 111 |
| -20 | 1-1/4 | 124 | 138 | 169 | 188 | 75 | 83 | 101-1/2 | 113 |
| -24 | 1-1/2 | 156 | 173 | 212 | 235 | 79 | 87 | 107 | 118 |
| -32 | 2 | 219 | 243 | 296 | 329 | 158 | 175 | 214 | 237 |

Table 5: For Flat-Face “O” Ring Seal (Steel)

| Size | | Ft-Lbs. | | Newton-Meters | |
|------|------------------|---------|------|---------------|------|
| Dash | Fractional (In.) | Min. | Max. | Min. | Max. |
| -4 | 1/4 | 10 | 12 | 14 | 16 |
| -6 | 3/8 | 18 | 20 | 24 | 27 |
| -8 | 1/2 | 32 | 40 | 43 | 54 |
| -10 | 5/8 | 46 | 56 | 60 | 75 |
| -12 | 3/4 | 65 | 80 | 90 | 110 |
| -14 | 7/8 | 65 | 80 | 90 | 110 |
| -16 | 1 | 92 | 105 | 125 | 240 |
| -20 | 1-1/4 | 125 | 140 | 170 | 190 |
| -24 | 1-1/2 | 150 | 180 | 200 | 245 |



Table 6: For SAE O-Ring Boss (Steel) & Gates Adapterless

| Size | | Ft-Lbs. Working Pressures 4,000 psi (27.5 Mpa) and below | | Newton-Meters Working Pressures 4,000 psi (27.5 Mpa) and below | | Ft-Lbs. Working Pressures Above 4,000 psi (27.5 Mpa) | | Newton-Meters Working Pressures Above 4,000 psi (27.5 Mpa) | |
|------|---------------------|---|------|---|------|---|------|---|------|
| Dash | Fractional (In.) | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. |
| -3 | 3/16 | — | — | — | — | 8 | 10 | 11 | 13 |
| -4 | 1/4 | 14 | 16 | 20 | 22 | 14 | 16 | 20 | 22 |
| -5 | 5/16 | — | — | — | — | 18 | 20 | 24 | 27 |
| -6 | 3/8 | 24 | 26 | 33 | 35 | 24 | 26 | 33 | 35 |
| -8 | 1/2 | 37 | 44 | 50 | 60 | 50 | 60 | 68 | 78 |
| -10 | 5/8 | 50 | 60 | 68 | 81 | 72 | 80 | 98 | 110 |
| -12 | 3/4 | 75 | 83 | 101-1/2 | 113 | 125 | 135 | 170 | 183 |
| -14 | 7/8 | — | — | — | — | 160 | 180 | 215 | 245 |
| -16 | 1 | 111 | 125 | 150 | 170 | 200 | 220 | 270 | 300 |
| -20 | 1-1/4 | 133 | 152 | 180 | 206 | 210 | 280 | 285 | 380 |
| -24 | 1-1/2 | 156 | 184 | 212 | 250 | 270 | 360 | 370 | 490 |

Table 7: Maximum Recommended Torque for dry NPTF (Tapered) Pipe Threads*

| Size | Ft-Lbs. | Newton-Meters |
|------|---------|---------------|
| -2 | 20 | 25 |
| -4 | 25 | 35 |
| -6 | 35 | 45 |
| -8 | 45 | 60 |
| -12 | 55 | 75 |
| -16 | 65 | 90 |
| -20 | 80 | 110 |
| -24 | 95 | 130 |
| -32 | 120 | 160 |

***NOTES:**

1. The torque values obtained from tightening pipe threads can vary considerably depending on thread condition. Adequate sealing can occur at values much lower than the maximum values listed above. Only enough torque to achieve adequate sealing should be used.
2. When using a male tapered pipe thread with a female straight or parallel pipe thread, maximum values are 50% of those listed in the table.
3. If threaded sealant is used, maximum values shown should be decreased by 25%

FASTENER TORQUE RECOMMENDATION

Table 8: Torque for Standard Fasteners

| Nominal Dia. (in.) | Threads per inch | Grade 2 | | | Grade 5 | | | Grade 8 | | | Grade 9 | | |
|--|------------------|-------------------|------------|-----------|-------------------|------------|------------|-------------------|------------|------------|-------------------|------------|------------|
| | | Tightening Torque | | | Tightening Torque | | | Tightening Torque | | | Tightening Torque | | |
| | | Lubed | Dry Plated | Dry Plain | Lubed | Dry Plated | Dry Plain | Lubed | Dry Plated | Dry Plain | Lubed | Dry Plated | Dry Plain |
| | | K = 0.15 | K = 0.17 | K = 0.20 | K = 0.15 | K = 0.17 | K = 0.20 | K = 0.15 | K = 0.17 | K = 0.20 | K = 0.15 | K = 0.17 | K = 0.20 |
| Unified Coarse Thread Series | | | | | | | | | | | | | |
| 1/4 | 20 | 49 in-lbs | 59 in-lbs | 66 in-lbs | 76 in-lbs | 86 in-lbs | 101 in-lbs | 107 in-lbs | 122 in-lbs | 143 in-lbs | 126 in-lbs | 143 in-lbs | 168 in-lbs |
| 5/16 | 18 | 101 | 122 | 135 | 157 | 178 | 209 | 221 | 251 | 295 | 259 | 294 | 346 |
| 3/8 | 16 | 15 ft-lbs | 18 ft-lbs | 20 ft-lbs | 23 ft-lbs | 26 ft-lbs | 31 ft-lbs | 33 ft-lbs | 37 ft-lbs | 44 ft-lbs | 38 ft-lbs | 43 ft-lbs | 51 ft-lbs |
| 7/16 | 14 | 24 | 29 | 32 | 37 | 42 | 49 | 52 | 59 | 70 | 61 | 70 | 82 |
| 1/2 | 13 | 37 | 44 | 49 | 57 | 64 | 75 | 80 | 90 | 106 | 94 | 106 | 125 |
| 9/16 | 12 | 53 | 63 | 70 | 82 | 92 | 109 | 115 | 130 | 154 | 135 | 153 | 180 |
| 5/8 | 11 | 73 | 87 | 97 | 113 | 126 | 150 | 159 | 180 | 212 | 186 | 211 | 248 |
| 3/4 | 10 | 129 | 155 | 172 | 200 | 227 | 267 | 282 | 320 | 376 | 331 | 375 | 441 |
| 7/8 | 9 | 125 | 160 | 167 | 322 | 365 | 429 | 455 | 615 | 606 | 633 | 604 | 710 |
| 1 | 8 | 187 | 225 | 250 | 483 | 547 | 644 | 681 | 722 | 909 | 799 | 905 | 1065 |
| 1-1/8 | 7 | 266 | 319 | 354 | 596 | 675 | 794 | 966 | 1095 | 1288 | 1132 | 1283 | 1510 |
| 1-1/4 | 7 | 375 | 450 | 500 | 840 | 952 | 1121 | 1363 | 1545 | 1817 | 1597 | 1810 | 2130 |
| 1-1/2 | 6 | 652 | 783 | 869 | 1462 | 1657 | 1950 | 2371 | 2688 | 3162 | 2779 | 3150 | 3706 |
| Fine Thread Series | | | | | | | | | | | | | |
| 1/4 | 28 | 56 in-lbs | 68 in-lbs | 75 in-lbs | 87 in-lbs | 99 in-lbs | 116 in-lbs | 123 in-lbs | 139 in-lbs | 164 in-lbs | 144 in-lbs | 163 in-lbs | 192 in-lbs |
| 5/16 | 24 | 112 | 135 | 150 | 174 | 197 | 231 | 245 | 278 | 327 | 287 | 325 | 383 |
| 3/8 | 24 | 17 ft-lbs | 20 ft-lbs | 23 ft-lbs | 26 ft-lbs | 30 ft-lbs | 35 ft-lbs | 37 ft-lbs | 42 ft-lbs | 49 ft-lbs | 43 ft-lbs | 49 ft-lbs | 58 ft-lbs |
| 7/16 | 20 | 27 | 32 | 36 | 41 | 47 | 55 | 58 | 66 | 78 | 68 | 78 | 91 |
| 1/2 | 20 | 41 | 49 | 55 | 64 | 72 | 85 | 90 | 102 | 120 | 105 | 120 | 141 |
| 9/16 | 18 | 59 | 71 | 78 | 91 | 103 | 121 | 126 | 146 | 171 | 151 | 171 | 201 |
| 5/8 | 18 | 82 | 99 | 110 | 127 | 144 | 170 | 180 | 204 | 240 | 211 | 239 | 281 |
| 3/4 | 16 | 144 | 173 | 192 | 223 | 253 | 297 | 315 | 357 | 420 | 369 | 418 | 492 |
| 7/8 | 14 | 138 | 165 | 184 | 355 | 403 | 474 | 502 | 568 | 669 | 588 | 666 | 784 |
| 1 | 14 | 210 | 252 | 280 | 542 | 614 | 722 | 765 | 867 | 1020 | 896 | 1016 | 1195 |
| 1-1/8 | 12 | 298 | 357 | 397 | 668 | 757 | 890 | 1083 | 1227 | 1444 | 1269 | 1439 | 1693 |
| 1-1/4 | 12 | 415 | 493 | 553 | 930 | 1055 | 1241 | 1509 | 1710 | 2012 | 1768 | 2004 | 2358 |
| 1-1/2 | 12 | 734 | 880 | 978 | 1645 | 1865 | 2194 | 2668 | 3024 | 3557 | 3127 | 3544 | 4169 |
| <p>Torque values for 1/4 and 5/16-in series are in inch-pounds. All other torque values are in foot-pounds Torque values calculated from formulas $T=KDF$, where K = 0.15 for "lubricated" conditions K = 0.17 for zinc plated and dry conditions K = 0.20 for plain and dry conditions D = Nominal Diameter F = Clamp Load</p> | | | | | | | | | | | | | |



Table 9: Torque-Tension Relationship for Metric Fasteners

| Nominal Dia. | Pitch |  Class 4.6 | | |  Class 8.8 | | |  Class 10.9 | | |  Class 12.9 | |
|--------------|-------|--|-------------------|-------------------|--|-------------------|-------------------|--|-------------------|-------------------|---|-----------|
| | | Tightening Torque | | | Tightening Torque | | | Tightening Torque | | | Tightening Torque | |
| | | Lubed | Dry Plated | Dry Plain | Lubed | Dry Plated | Dry Plain | Lubed | Dry Plated | Dry Plain | Lubed | Dry Plain |
| (mm) | | K = 0.15 (ft-lbs) | K = 0.17 (ft-lbs) | K = 0.20 (ft-lbs) | K = 0.15 (ft-lbs) | K = 0.17 (ft-lbs) | K = 0.20 (ft-lbs) | K = 0.15 (ft-lbs) | K = 0.17 (ft-lbs) | K = 0.20 (ft-lbs) | K = 0.15 | K = 0.20 |
| 3 | 0.5 | 0.28 | 0.32 | 0.38 | 0.73 | 0.82 | 0.97 | 1.0 | 1.2 | 1.4 | 1.2 | 1.6 |
| 3.5 | 0.6 | 0.44 | 0.50 | 0.59 | 1.1 | 1.3 | 1.5 | 1.6 | 1.9 | 2.2 | 1.9 | 2.5 |
| 4 | 0.7 | 0.66 | 0.74 | 0.87 | 1.7 | 1.9 | 2.3 | 2.4 | 2.7 | 3.2 | 2.8 | 3.8 |
| 5 | 0.8 | 1.3 | 1.5 | 1.8 | 3.4 | 3.9 | 4.5 | 4.9 | 5.5 | 6.5 | 5.7 | 7.6 |
| 6 | 1 | 2.3 | 2.6 | 3.0 | 5.8 | 6.6 | 7.7 | 8.3 | 9.4 | 11 | 9.7 | 13 |
| 6 | 1.25 | 2.1 | 2.3 | 2.7 | 5.3 | 6.0 | 7.0 | 7.6 | 8.6 | 10 | 8.8 | 12 |
| 7 | 1 | 3.8 | 4.3 | 5.0 | 9.7 | 11 | 13 | 14 | 16 | 19 | 16 | 22 |
| 8 | 1 | 5.9 | 6.6 | 7.8 | 15 | 17 | 20 | 22 | 24 | 29 | 25 | 34 |
| 8 | 1.25 | 5.5 | 6.2 | 7.3 | 14 | 16 | 19 | 20 | 23 | 27 | 24 | 31 |
| 10 | 1.25 | 11 | 13 | 15 | 29 | 33 | 39 | 42 | 48 | 56 | 49 | 66 |
| 10 | 1.5 | 11 | 12 | 14 | 28 | 32 | 37 | 40 | 45 | 53 | 47 | 62 |
| 12 | 1.25 | 21 | 23 | 28 | 53 | 60 | 71 | 76 | 86 | 101 | 89 | 119 |
| 12 | 1.5 | 20 | 22 | 26 | 51 | 58 | 68 | 73 | 82 | 97 | 85 | 113 |
| 12 | 1.75 | 19 | 21 | 25 | 49 | 55 | 65 | 70 | 79 | 93 | 81 | 108 |
| 14 | 1.25 | 26 | 29 | 34 | 66 | 75 | 89 | 95 | 106 | 127 | 111 | 148 |
| 14 | 1.5 | 28 | 32 | 37 | 72 | 82 | 96 | 103 | 117 | 138 | 121 | 161 |
| 14 | 2 | 30 | 34 | 40 | 78 | 88 | 104 | 111 | 126 | 148 | 130 | 173 |
| 16 | 1.5 | 50 | 57 | 67 | 129 | 146 | 171 | 184 | 208 | 245 | 215 | 287 |
| 16 | 2 | 47 | 53 | 62 | 121 | 137 | 161 | 173 | 196 | 230 | 202 | 269 |
| 18 | 1.5 | 73 | 82 | 97 | 187 | 212 | 249 | 266 | 303 | 357 | 313 | 417 |
| 18 | 2.5 | 65 | 73 | 86 | 167 | 189 | 222 | 239 | 270 | 318 | 279 | 372 |
| 20 | 2.5 | 91 | 104 | 122 | 236 | 267 | 314 | 337 | 382 | 449 | 394 | 525 |

Clamp load calculated as 75% of the proof load for specified bolts.
 All Torque values are listed in foot-pounds
 Torque values calculated from formulas $T=KDF$, where
 K = 0.15 for "lubricated" conditions
 K = 0.17 for zinc plated and dry conditions
 K = 0.20 for plain and dry conditions
 D = Nominal Diameter
 F = Clamp Load

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