MART Standard Turntable Power Washer
Installation, Operations, and Maintenance Manual

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Power Blast Manifold (PBM), Auto Rinse Cycle, Rinse Bank, Single Ball Float Control, Wet Grit Blasting feature, NPSH reduction system, Automatic Pressure Equalization (APE), Fold-up Turntable and Clean Machine are protected by one or more of the following U.S. Patents: 4,741,351; 4,143,669; 4,213,475, 5,529,080; 5,524.653; 5,427,128; 5,540,246.

MART has attempted to provide a Manual that is reliable and accurate. Note that the information contained in this Manual is subject to change at any time without notification. The information contained in this version of the Manual supersedes all previous versions, while some information may not be accurate due to changes in the product or operating system since this version of the Manual was completed. Please report any discrepancies or omissions to MART. No liability is assumed with respect to the information contained herein.

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Welcome and Introduction

This section describes this manual and other resources that will help you get the most out of your MART Power Washer. Before you use the washer, read the entire manual to learn about installation, operations, maintenance, and troubleshooting.

Refer to chapter *"Options"* for descriptions of any options you have purchased.

Purpose of Manual

The *MART Standard Turntable Power Washer* manual is a comprehensive guide that contains information and operating instructions/procedures you need to operate the power washer as intended. *Operating instructions are also referred to as "procedures" in this manual.*

The next section, *Important Safety Instructions and Warnings,* contains general warnings and cautions that are meant to be observed at all times when you work with the washer. Personnel training is required to work with the power washer. *Be sure all operators and maintenance personnel read and UNDERSTAND the instructions in this section*. In addition, operating instructions/procedures are preceded as necessary by warnings and cautions that alert operators to reasonably foreseeable risks of injury to people or damage to property.

> ***IMPORTANT! Keep this manual and all safety and operating instructions. Operators must refer to them to safely install, operate, maintain, repair, troubleshoot, or work with the washer in any way.***

MART knows that its ***customers don't want washing machines ... they want clean parts***. The manual has been written with this objective in mind, and every chapter, from *"Installation"* to *"Troubleshooting"* and *"Options,"* provides guidelines and suggestions for helping you achieve that goal ... *safely*.

Audience

This manual is intended for you, if you need to clean parts, whether you have already bought a MART Power Washer system or are thinking about buying one. You will find MART Power Washers in all types and sizes of shops and manufacturing facilities -- wherever there are tough industrial cleaning problems.

Those who will find this manual especially useful include the following:

- Maintenance supervisors
- Maintenance staff
- Manufacturing engineers
- Operators
- Shop supervisors
- Contractors

How the Manual Is Organized

Review the *Table of Contents* to get a feel for what is in the manual, and where it is located. The *List of Figures* lists all graphics by figure number and title, and refers you to the correct page.

Important Safety Instructions and Warnings contains general warnings and cautions that are meant to be observed at all times when you work with the washer. Be sure all operators read and heed the instructions in that section.

Chapter 1, "Overview," presents an overview of the MART Standard Turntable Power Washer, including a theory of operation.

Chapter 2, "Installation," explains how to install the MART Power Washer. Pay special attention to the prerequisites, particularly placement planning, and to the safety/precaution information.

Chapter 3, "Basic Operations," provides step-by-step instructions on how to load and wash parts.

Chapter 4, "Advanced Operations: Process-Control," describes how to establish operating parameters to optimize the performance of your power washer.

Chapter 5, "Maintenance," discusses the maintenance of your power washer. Use the information in this chapter to establish and follow a service schedule.

Chapter 6, "Troubleshooting," contains problem symptoms/probable causes for key assemblies and components of your washer. Use this chapter to help diagnose and correct a problem.

Chapter 7, "Options," contains installation, operations, maintenance, and troubleshooting information on the Clean Machine and any other power washer options you may have purchased from MART.

At the end of the manual you will find an *Index*. Use it to find information quickly.

How to Use This Manual

Read the entire manual *before* you attempt to install, operate, or maintain the power washer. This will provide the foundation you need to understand how the washer works and how to use it to your best advantage.

Staff members who are responsible for specific features or functions will benefit from paying special attention to corresponding information in the manual.

After you have read the entire manual thoroughly, use the *Table of Contents*, *List of Figures*, and *Index* to refer to information, as you need it.

MART Technical Services

MART's technical services department is available to provide you with the extra support you might occasionally need.

If you have a question about the washer or its operation, first look in this manual and in other printed product-support documentation. If you cannot find the answer, contact *MART Technical Services*. Our phone number is on the title page near the beginning of the manual, and in the following section, *"Other Resources -- HELP."*

Before your power washer is delivered, you will receive a courtesy call from MART technical services. Our expert engineers and technicians will review your specifications and answer questions about placement planning, installation, utility and service requirements.

Other Resources

In addition to this manual and our technical service staff, MART offers the following product support:

- Vendor-supplied manuals
- Startup
- HELP
- Other product-support services

Vendor-supplied Manuals

Your washer is delivered with vendor-supplied manuals and cutsheets for some assemblies and parts. Refer to these documents for additional details on installation, operations, and maintenance.

Startup

A MART factory-trained technician is optionally available to perform startup and customer training. Call MART technical services to request this service.

As part of this service, the MART technician will fill in the *Field Startup Procedure (FSP)* form to begin your one-year warranty coverage.

HELP

If you can't find the answer to your question in this manual, contact MART:

The MART Corporation
2450 Adie Road
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***Missouri Direct*: (314) 567-7222**
***Fax*: (314) 567-6551**
E-mail: themart@martwash.com
Website: www.martwash.com

Other Product-Support Services

Contact MART to receive the following information:

Audio Cassettes:

"Shop Productivity and Profit"
"Bake Ovens, EPA, OSHA, and Hazardous Waste Disposal"
"How MART Power Washers Work"

Printed Material:

- Hazardous waste lab reports
- Procedure for sludge disposal
- Message to financial management
- Ins & outs of leasing
- Performance specifications for the power washer in which you are interested
- List of users
- Testimonials
- MART parts cleaning cost analysis

Videos:

- All About Parts Washing
- EQ-1 Training Video

MART Website: www.martwash.com

Important Safety Instructions and Warnings

The following important safety instructions and warnings apply to installing, operating, maintaining, and troubleshooting the MART Power Washer. They also apply to repairing the washer, or to working with it in any way.

Read all of the following safety instructions and warnings thoroughly *before* you install, operate, maintain, troubleshoot, repair the washer, or work with the washer in any way!

SAVE THE SAFETY INSTRUCTIONS AND WARNINGS IN THIS SECTION!

GENERAL SAFETY INSTRUCTIONS FOR OPERATING THIS PRODUCT:

1. ***Read all safety and operating instructions/procedures before installing, operating, maintaining, repairing, or troubleshooting the washer ... or working with it in any way.***

2. ***Know how to STOP the washer. Be familiar with all its controls.***

3. ***Stay alert at all times, and watch what you are doing.***

4. ***Do not operate the washer if you are tired, or if you have had anything alcoholic to drink, or if you have taken any drugs, including prescription medications.***

5. ***Keep the operating area clear of people.***

6. ***Do not overreach or stand on unstable support. Keep good footing and balance at all times.***

7. ***Follow the instructions given in this manual for installation, operations, maintenance, and troubleshooting.***

CAUTION! GROUNDING INSTRUCTIONS: The washer must be grounded! Grounding provides a path of least resistance for electric current, thus reducing the risk of electric shock during maintenance, troubleshooting, or repair.

CAUTION! GROUNDING INSTRUCTIONS: The washer must be connected to a grounded, metal, permanent wiring system; OR an equipment-grounding conductor must be run with the circuit conductors and connected to the equipment-grounding terminal or lead on the washer.

WARNING! IF YOUR POWER WASHER USES A GAS BURNER: If you do not follow installation and operating instructions exactly, a fire or explosion may result, causing loss of life, personal injury, or damage to property.

WARNING! VENTING OF EXHAUST GASES: Do NOT vent exhaust gases into a wall, a ceiling, or a concealed space of a building. Refer to the instructions in this manual for correct venting instructions.

WARNING! Do NOT overload the THERMAL RESERVOIR COVER or other HORIZONTAL SURFACES. The covers are chemical-solution covers and are not designed for walking or standing. Other horizontal surfaces are not designed for walking or standing. Walking on the thermal reservoir cover, tank cover, or other horizontal surfaces could result in serious injury or death.

CAUTION! All MART Power Washer systems use a water-based alkaline cleaner. DO NOT attempt to use any type of organic solvent, emulsion cleaner or acid! USE ONLY water-based alkaline cleaners! Use of chemicals not recommended by MART will void your warranty and can be dangerous resulting in possible personnel injury.

WARNING! NEVER attempt to disable the automatic pressure equalization (APE) timer or the wash-delay timer on the wash pumps and start-up system! Disabling the APE timer or the wash-delay timer can cause water hammer to occur, resulting in severe damage or injury.

WARNING! Be sure that people installing the power washer are qualified and trained for the task.

WARNING! Set up your power washer installation to conform to all local code requirements.

WARNING! The standard power washer is designed to be installed inside a building, not outside.

WARNING! <u>DO NOT EVER</u> get inside the washer cabinet when the main power supply is ON. This could result in severe injury or death.

CAUTION! <u>WHEN LOADING AND UNLOADING PARTS</u>! -- Always wear gauntlet-type thermally protected and water-repellent protective gloves, protective eyewear, a filter-type air mask, and a full body apron that is thermally protected and water-repellent.

WARNING! Be sure that people performing maintenance are qualified and trained for the task.

WARNING! Be sure that people performing repairs are qualified and trained for the task.

WARNING! Disconnect/turn OFF power before opening the control panel. NEVER leave the control panel open when the power is ON.

CAUTION! You must turn the main power supply OFF before performing many maintenance procedures. BE SURE to turn the main power supply back ON after you perform maintenance.

CAUTION! If the main power supply is OFF for a time period that exceeds the power-outage carry-over specified in the vendor-supplied 7-Day-Clock Manual, be sure to re-set the 7-Day Clock (located inside the electrical control panel).

SAVE THE SAFETY INSTRUCTIONS AND WARNINGS IN THIS SECTION!

1 Overview

Purpose

This chapter introduces you to the *MART Standard Turntable Power Washer*. Read it to gain a general understanding of your power washer *before* you attempt to install, operate, or maintain the washer.

Prerequisites

You will find it helpful to have read the introductory material, especially *"Welcome,"* so that you understand how this manual is organized.

What You Will Learn In This Chapter

In this chapter you will learn about the following:

- Your new MART Power Washer
- Materials and components
- Theory of operation
- Washer inspection

1. Your New MART Power Washer

Your new MART Power Washer is an engineered state-of-the-art machine designed to exacting standards in order to give you the highest-quality cleaning. Your washer incorporates the many technological and engineering advances we have made at MART in our ongoing research-and-development program.

Read this section for a general understanding of the washer's purpose, usage, and manufacturing information. This section also shows you a diagram of the washer, with principal parts labeled.

1.1. Getting Acquainted

MART Power Washers are non-solvent-based cleaning systems. They are designed to clean parts in a wide range of industrial settings, for example, in the rebuilding of engines and brake systems, electric motors, and during manufacturing assembly.

All MART Power Washers operate automatically. With reasonable care and maintenance, your washer will give you years of top-quality cleaning.

1.2. Major Components

The following figure shows the MART Standard Turntable Power Washer. The principal parts are labeled. Major features of the power washer are explained in the next several sections.

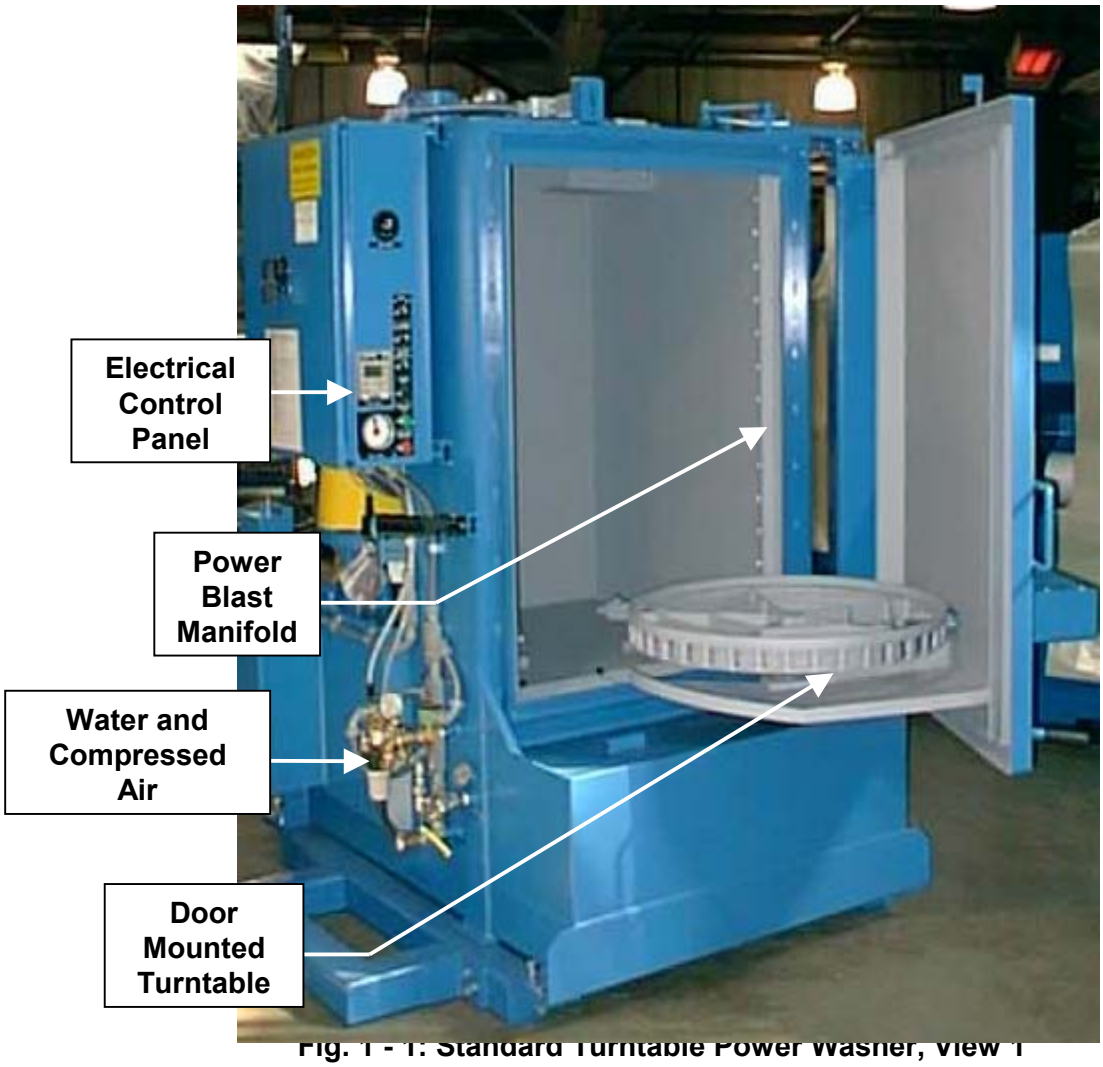


Fig. 1 - 1: Standard Turntable Power Washer, View 1

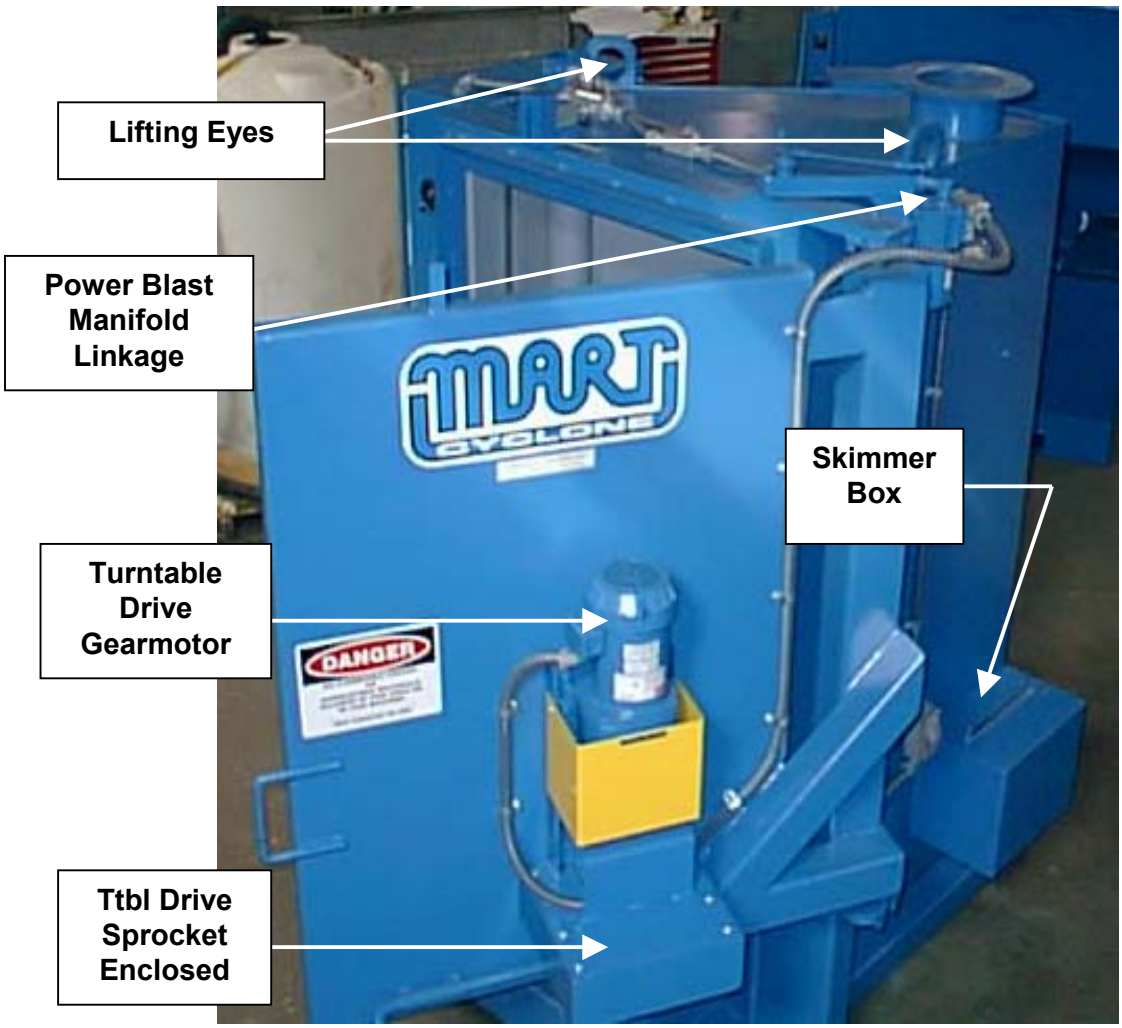


Fig. 1 - 2: Standard Turntable Power Washer, View 2

2. Materials, Components & Standards of Construction

All MART Power Washers are American-made, using high quality, industrial-grade materials and components. The machine and control system is designed and built to meet the stringent standards of ANSI/NFPA-79 (American National Standards Institute/National Fire Protection Agency) electrical standards for industrial machinery.

2.1. Electrical Standards

All electrical components are UL approved.

Wiring is numbered and color-coded THHN 14-gauge minimum with thermoplastic insulation.

A power disconnect interlocked with the electrical-control-panel enclosure door is available on all MART power washers.

Nameplates identify each electrical device (*for example*, pump, turntable and skimmer motors; solenoid valves) outside the electrical control panel, and all electrical devices (*for example*, timers, relays, motor starters) inside the electrical control panel are clearly labeled.

Separate temperature-compensated overloads are provided for each motor load. Each motor has a separate ground-wire pulled through a conduit and attached to the back panel of the electrical control panel to ensure a positive earth-ground without relying on the machine structure to supply the grounding path.

A transformer provides control power and allows for a single source of power to the machine.

All fusing is rated at 200,000 AMP interrupt capability.

All operator controls are oil-tight, providing reliable operation under the harshest environmental conditions.

2.2. Cabinet Construction

Cabinets are built of boilerplate sheet steel, with seams continuously MIG-welded for superior strength. Box tubing and angle have 1/4-inch-thick to 1-inch-thick (6mm - 25 mm) walls. All exterior surfaces are primed and coated with a two-part Polyamide-Epoxy.

3. Theory of Operation

MART defines the term *to clean* as *to overpower the soils*. The MART Power Washer is a high-impact pressure, high-temperature, water-based cleaning system that uses a combination of the following factors to achieve cleaning results:

Power x Temperature x Chemical x Time = Clean

The relationship of these variables can be varied in an infinite number of ways to achieve the same level of cleanliness. Your own needs determine the relative value of each variable. Keep in mind that the MART Power Washer provides one of the highest blasting powers in the cleaning industry, allowing you to reduce wash-cycle times to a minimum. Additionally, the high blasting power allows you to operate the washer at lower cleaning temperatures, thus saving energy, and using less chemical than spray washers.

The *exact* combination of the factors must be determined for your application, based on the types of soils to be removed, the degree of cleanliness required, the cycle time required, the types of parts to be cleaned, and so on.

3.1. How the Power Washer Works

The power washer operates on a timed cycle. The operator places the parts to be cleaned in the washer on the turntable, closes and latches the door, and then starts the timed cleaning cycle.

During the cleaning cycle, a high-temperature, high-pressure, water-and-detergent cleaning solution blasts soils from the parts.

After the cycle has stopped and the steam has exhausted, the operator removes the cleaned parts.

The power washer utilizes closed loop, waste minimization technology, continuously reusing its cleaning solution and effectively reducing pollution potential. (The optional Clean Machine further reduces pollution.) And, because the washer is fully enclosed, it is safe for the operator, since the high-pressure, high-temperature spray is locked inside the cabinet.

In order to better understand how the four factors affect cleaning, let's look at each one more closely:

- Power
- Temperature
- Chemical
- Time

3.1.1. Power

The first key factor in the power washer's ability to clean is *power* -- the blasting power required to strip even the toughest soils from parts.

Pressure and Flow = Power

Power means the physical forces that remove the soils. The following formula expresses in horsepower (HP) the "cutting power" of the solution blasted from each nozzle tip:

HP = (GPM x PSI) / 1714

GPM (gallons per minute) = flow per nozzle
PSI (pounds per square inch) = pressure

In general, MART systems blast with four to 100 times more "cutting power," depending on pump size, than jet spray systems.

What really counts, however, is *impact pressure* -- the force of the spray at the target surface. It is impact pressure that most directly affects how quickly and effectively the soils are removed. The impact per square inch of a given nozzle depends on the following:

- Flow and pressure produced by the pump
- Type of nozzle
- Spray pattern distribution
- Spray angle

MART cleaning systems achieve an optimal balance of these factors to provide the highest impact pressure at the part surfaces.

Closed-Loop System and Grit-Blasting

The MART Power Washer is a closed-loop system. This means that none of the washing or rinsing solution is discharged. Therefore, as soils are removed from parts, a patented feature reclaims the grit and blasts it back at the wash load to provide a vigorous scouring action, without any damage to parts. Thus, the grit becomes a valuable cleaning medium and actually acts to increase the impact pressure.

Note: In applications where the wet grit blast is not desired, MART can provide fine filtration, including sub-micron filtration, to remove it.

In terms of results, wet grit blasting means that the dirtier the power washer gets, the faster it cleans. This feature is desirable for most rebuilding applications and some manufacturing ones.

3.1.2. Temperature

As temperature increases, greases and oil become more fluid; in other words, their viscosity decreases. Since grease is the primary binder that holds and contains the soils on the parts, higher washing temperatures above 160° F (71° C) generally produce better cleaning results.

Secondly, chemical is more aggressive at higher temperatures. As a general rule, for every 10° F (-12.22° C) rise in temperature above 160° F, a chemical reaction doubles in speed.

3.1.3. Chemical

Chemical is the third key factor in overpowering soils and removing them from the surface of parts. While chemicals are necessary to enhance the cleaning process, your MART Power Washer does not rely primarily on chemical concentration. This is because your MART sales technician worked with you to determine your cleaning needs, such as:

- Required degree of cleanliness
- Nature of the soils to be removed
- Pump size and performance requirements
- Size, shape and surface of the parts to be cleaned
- Applications and usage of the power washer in your shop

Because your MART Power Washer's configuration has been customized specifically to meet your requirements, the washer will successfully meet your cleaning standards when charged with a *light* chemical concentration, as compared to conventional washers. In general, this means that a 2-5% concentration by volume of a quality non-foaming chemical compound will give excellent cleaning results. However, like temperature and power, the exact type and amount of chemical are subjective and depend on your shop's needs.

Chemical cleaners fall into three general categories:

- Organic solvents
- Emulsion cleaners
- Aqueous (water-based) alkaline cleaners

MART systems use an aqueous (water-based) alkaline cleaner, not a solvent, so you don't have to deal with solvent vapors or hazardous-waste contaminants. Generally, the

water-based alkaline cleaner is composed of water, an alkali source, a sequestrate, a surfactant package, and corrosion inhibitors.

A *sequestrate* is a binding agent that prevents undesirable chemical reactions, such as those that would form insoluble products like hard-water soap scum. The *surfactant* is a substance that lowers surface tension in order to penetrate and loosen soils. It coats oil droplets to prevent them from recombining. A *corrosion inhibitor* slows down the rate of chemical reaction that produces rust.

The water-based alkaline cleaner works by undercutting the soil, then "popping" it from the part surface. Light oils float to the solution surface, where they can be skimmed or filtered off. Heavier soils sink to the bottom, and can be filtered or removed as sludge.

A key feature of this type of cleaner is that you only have to dispose of the *contaminants* as waste -- the washer can recycle the *liquid until the saturation point.* As the wash solution is used it will become increasingly more contaminated. At some point, the solution will become fully saturated and it will become necessary to change the wash solution and recharge the washer with new water and chemical.

Call The MART Corp. for information on recycling technologies.

Removal of Soils

The water-based alkaline cleaner readily removes the following soils:

- Cutting oils
- Shop dirt
- Low-melt waxes
- Rust preventatives
- Finger prints
- Paint
- Cosmoline
- Varnish
- Grease
- Mill markings
- Diesel carbon
- Carbon dust
- Coolants
- Road soils
- Oil and chips

Applications

The water-based alkaline cleaner has many applications. It is successfully used, for example, in the following ways:

- Pre-clean
- Before teardown
- Before plating
- Before Re-assembly
- At the finishing process before packaging
- Before painting
- During in-process cleaning
- Before anodizing

Usage

When you work with a water-based alkaline cleaner, remember these points:

1. Most parts "flash"-dry within a minute or two after removal from the washing cabinet.

2. Parts that sit for some time before the next in-process operation are protected by a layer of corrosion inhibitor.

3. You can easily remove the layer of corrosion inhibitor by a water rinse. MART can provide an optional Auto Rinse Cycle (ARC) for your washer that will remove chemicals and oils with heated fresh water to "flash"-dry parts without rusting.

4. If you need to dry the parts quickly, MART can provide an air or heated drying phase.

5. All parts and materials washed in a MART Power Washer are clean and generally paintable without further preparation.

6. In cleaning parts, you will have to periodically adjust the chemical concentration.

3.1.4. Time

Time lets power, temperature, and chemical do their work in overpowering soils and removing them from parts. If soils are heavy and built-up, for example, setting a longer wash-cycle time will clean the parts.

MART Power Washer wash-cycle times are more efficient than those of conventional washers, due to the greater power of the system do. This power comes from the following:

- MART pump technology
- MART oscillating Power Blast Manifold

3.1.5. General Information and Conclusion

This section, "*Theory of Operation*," has given you an overview of how the MART Power Washer operates.

MART defines the term *to clean* as *to overpower the soils*. *Cleanliness* is proportional to the combination of the following factors:

- Power
- Temperature
- Chemical
- Time

The *exact* combination of these factors is variable and depends on your cleaning standards and operating requirements for the materials that you are cleaning. Since cleaning standards vary from shop to shop, through testing you can achieve an optimal balance of these four factors to meet your cleaning standards.

3.2. Operating Principles of Key Features

This section describes the key features of the standard turntable power washer and their operating principles. The features are presented in general functional order. As you read, you may wish to refer to Figs. 1-1 and 1-2.

3.2.1. Pumping System

The pumping system is the heart of the power washer. MART's inventive pump suction/discharge allows pumps to operate at blast pressures far higher than those of conventional power washers.

Pump Assembly: A flexible coupling joins the pump and electric-motor shafts. The pump is barrel-mounted and seal-less, without bearings or other metal-to-metal contact in the "wet end." The pump and the motor are mounted on a structural steel baseplate. Principal pump components are a casing, shaft, impeller, backhead or suction head, baseplate, discharge piping, bearing frame, and bearings.

Basic Pump Function: The pump draws solution through the 3/16-inch - diameter (5 mm) openings of the pump suction filter. The solution is drawn through the suction tube to the pump inlet. Finally, the solution leaves the pump under pressure and travels through piping to the power blast manifold (PBM). The pump is capable of handling hot alkaline cleaners, and can pass solids and grit up to 1/2-inch (13 mm) in diameter.

Pump Motor: Pump motors are industrial grade TEFC with a minimum 1.15 Service Factor, Class "F."

3.2.2. Power Blast Manifold (PBM)

After the cleaning solution leaves the pump, it travels through piping to the power blast manifold (PBM), where it is distributed to the spray nozzles. U.S. Patent 4,741,351 protects the PBM's unique design.

PBM Assembly: The PBM is supported and rotates between the upper bearing at the cabinet roof and the (sealed) swivel joint near the cabinet floor. The *sealed swivel joint a*ffords the best connection between a *stationary* pipe and a *rotating* assembly, because the joint allows high-pressure, high-temperature flow into the PBM assembly as it rotates on bearings. The swivel joint makes it possible to hard-connect steel pipe to steel pipe and still be able to rotate the assembly.

Nozzles: The opening diameter of the nozzles is larger than the 3/16-inch (5 mm) openings in the pump suction filter. Therefore, grit that will pass through the filter will also go through the manifold assembly and the nozzles. The result is that the entire system is virtually self-cleaning.

Basic PBM Function: The PBM pivots on its vertical axis, driven by a gear motor through a crank-and-arm linkage that produces a 46° angle of oscillation and return throughout the wash cycle. The sweep and speed of the PBM are not synchronized to the turntable, so the wash load is blasted from a different angle with each pass at the nozzles. The offset upper and lower PBM arms allow each nozzle to blast on its own plane without deflecting the blast from other nozzles in the manifold -- this ensures that virtually all the blasting force reaches the parts.

The rotating PBM offers several advantages over a fixed manifold. In terms of cleaning results, the most important advantage is that the non-synchronous rotation of the PBM relative to the turntable rotation blasts the wash loads from different angles with each turntable pass by the wash nozzles. The recesses and pockets that would be hidden to a fixed manifold are accessible to the oscillating PBM. This means cleaner parts.

Nozzles: Nozzle placement evenly distributes blasted solution throughout the wash cabinet: From the bottom up, across the cabinet, and from the top downward. This ensures that each portion of the wash load comes clean at about the same time in a single wash cycle.

3.2.3. Door-Mounted Turntable

The turntable is designed and engineered to the highest safety standards. It is capable of supporting loads from 1,700 lbs. (770 kg) to 40,000 lbs. (18140 kg), depending on power washer size.

Turntable Assembly: The turntable is mounted on the inside of the cabinet door on the turntable support arm. The turntable swings fully out of the cabinet when the operator opens the door. This allows easier loading, including the use of an overhead crane. The turntable uses the highest quality industrial bearings that, with scheduled greasing, should last the life of the power washer. During loading, the turntable may be rotated for easier placement of parts by pressing the "jog" button on the control panel.

Basic Turntable Function: During the wash cycle the turntable rotates at approximately 29 feet (8.9 m) per minute. The rotation is not synchronized to the sweep and speed of the PBM. The turntable is driven by the turntable drive system.

3.2.4. Turntable Drive System

This system rotates the turntable and controls its speed. It also serves as a clutch to allow table slippage, if a wash load shifts and jams the turntable.

Turntable Drive System Assembly: The drive motor assembly mounts onto a small box on the door of the cabinet. The assembly's key features are a gear motor, a slip-clutch shaft coupling, two flange mount bearings, the plastic drive sprocket, and a sprocket support plate. The slip clutch is located just below the drive motor and couples the motor shaft to the sprocket jackshaft. The sprocket is mounted on the end of the jackshaft.

Basic Turntable Drive System Function: The drive system uses a plastic drive sprocket to engage and drive the sprocket teeth on the turntable. If factory-preset torque is exceeded, the slip clutch functions as a torque limiter, and slips.

3.2.5. Automatic Steam Exhaust (ASE)

The automatic steam exhaust (ASE) system is designed to remove steam from the power washer cabinet *during* the wash cycle and the optional automatic rinse cycle (ARC); and for a timed period *after* the rinse cycle.

The ASE serves two purposes:

1. It reduces the amount of steam that leaks into the shop area during the wash cycle, and when the door is opened.

2. It makes room for rinse water to be used as makeup water, when the ASE is used in conjunction with the optional ARC. (See "*Automatic Rinse System (ARC)"* section below)

Basic ASE Function: The ASE is a draft-induced system. A fan creates a nominal negative pressure inside the cabinet to pull steam out of the cabinet through the steam-exhaust piping. The nominal negative pressure ensures that minimum vapor and heat energy losses occur during power washer operation.

3.2.6. Automatic Rinse System (ARC)

The automatic rinse system (ARC) is a fresh-water rinsing system. It uses waterline pressure to provide a rinse of parts after the wash portion of a cleaning cycle. A chemical injector pump in the system provides for application of rust inhibitor during the rinse cycle. The chemical injector pump allows adjustment of the flow rate of chemical injected into the rinse water. The pressure regulator and gauge allow the operator to adjust the rinse spray characteristics of flow and pressure.

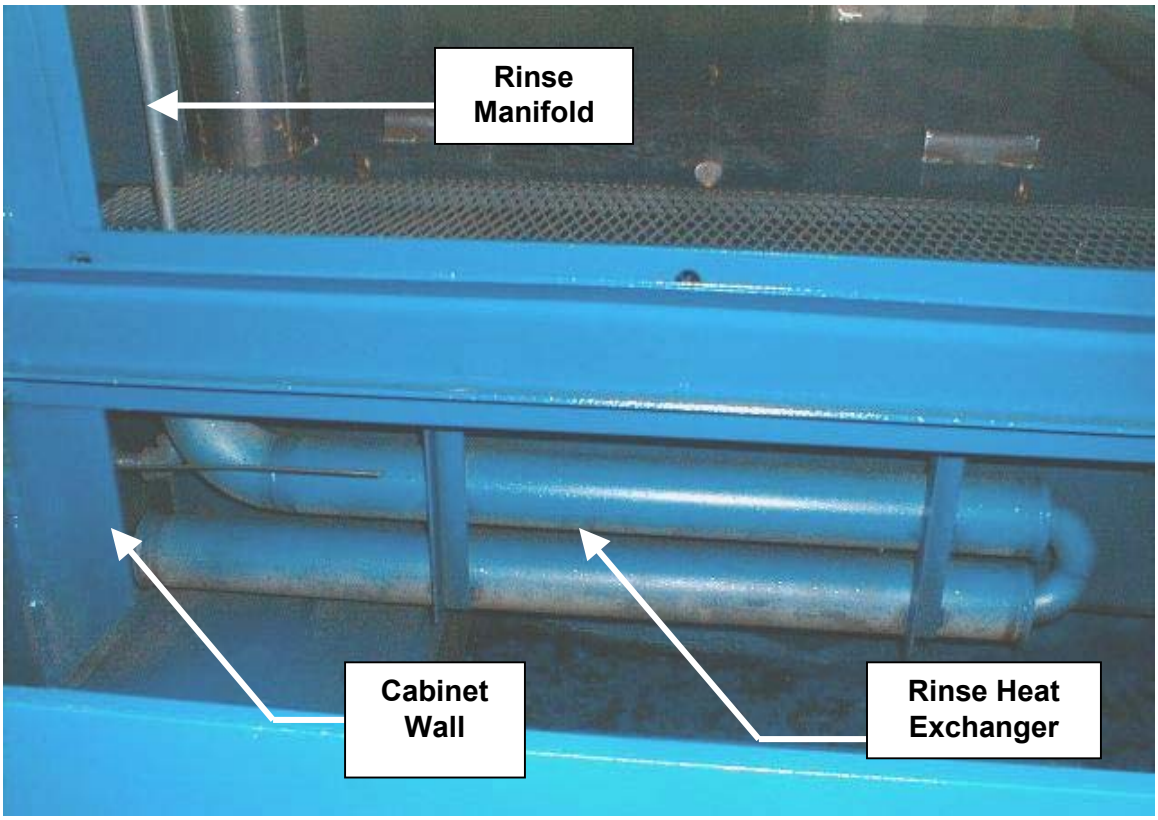


Fig. 1 - 3: Rinse System

All rinse-system components in the washer cabinet are made of stainless steel. External parts are made of corrosion-resistant materials.

Rinse time is controlled by two factors:

- The amount of water that can be made up, due to water loss through steam-exhaust evaporation or drag-out;

- or -

- The rinse timer inside the control panel.

In terms of rinse cycle time, water loss takes priority: The amount of required makeup water determines the maximum rinse time allowed, if any.

Basic ARC Function: Rinse water is filtered and its pressure is regulated before it reaches a solenoid valve. When a rinse cycle begins, the solenoid valve opens, allowing fresh water to enter the rinse system. As the water enters through the valve, the chemical injector pump pumps rust inhibitor into the rinse water. Next, the water is heated as it travels through a heat exchanger mounted in the wash-solution reservoir. From there the water flows into the fixed rinse manifold and sprays out through nozzles onto the parts.

Rinse water becomes makeup water, so no solution is discharged outside the cabinet. This also improves chemical management, because all rinsed chemical remains in the reservoir.

3.2.7. Heating System

There are three types of heating systems available for the power washer:

- Gas (natural gas or propane)
- Electric
- Steam

First, let's look at general operating principles that apply to all the systems. Following that we'll take a closer look at principles specific to each system.

Note: The discussions of heating-system operating principles assume that the 7-day clock would be set to allow heating to occur.

Basic Heating System Function: A thermocouple measures water temperature. It is connected to the electronic temperature controller, which turns the heating device on or off, depending on the *set point*. (The temperature controller is located inside the control panel.)

Specific Systems

Gas Burner: The forced-air gas burner fires into an immersion-tube heat exchanger. Exhaust gases are removed through the flue pipe.

Electric: Immersion heating elements are threaded into the cabinet wall, suspending them in the solution. An electrical contactor in the control panel supplies power to the elements.

Steam: This type of system contains a control valve, a stainless-steel heat exchanger, and a steam trap. When heat is required, the valve opens, and pressurized steam flows into the heat exchanger. Steam condense is released from the heat exchanger through the steam trap.

3.2.8. Water-Level Control System

The float system supplies water-level information for the rinse, water-fill, and heating systems. The principal features of the system are:

- Additional available rinse water.
- Low solution level detection that provides system protection for both the wash pumps and the heating system.
- High-level indication that can be used to initiate a maximum/overfill warning light or alarm.

Basic Solution-Level Control System Function: The float system is able to detect four water levels via two limit switches and a torpedo-shaped cam. A relay in the control panel is connected to each limit switch. With the various combinations of the ON and OFF positions of the two limit switches, the system is able to detect the following four water level conditions:

LOW-LOW: The wash pump and heating systems are disabled to prevent damage to these systems. When the water level is below LOW-LOW, neither the heating system nor the wash pumps will function. The water-fill valve will be open to provide water-fill.

LOW: This is the minimum safe operating condition. The heat exchanger should be fully submerged and the pump suction filter screen should be fully submerged. Once the water level reaches the LOW position, the heating system and the wash pumps will be enabled. The washer can operate at this condition. When the machine is not in a cleaning cycle (wash, rinse, and hot-air blow-off, ASE), the water-fill valve will open and fill the machine to the SET POINT.

SET POINT: This is the minimum water level when the machine is not in a cleaning cycle. The machine will automatically fill to this level. Reservoir volume between the SET POINT and HIGH is called the ***rinse-bank***.

HIGH: Whenever water level is above the HIGH level, the water-fill and rinse are disabled. This is the maximum water level possible for operation of the machine.

The following figure shows the four different levels detected by the float system and the positions of the two limit switches at each level. Below each diagram is a table that shows which systems are enabled or disabled at each level.

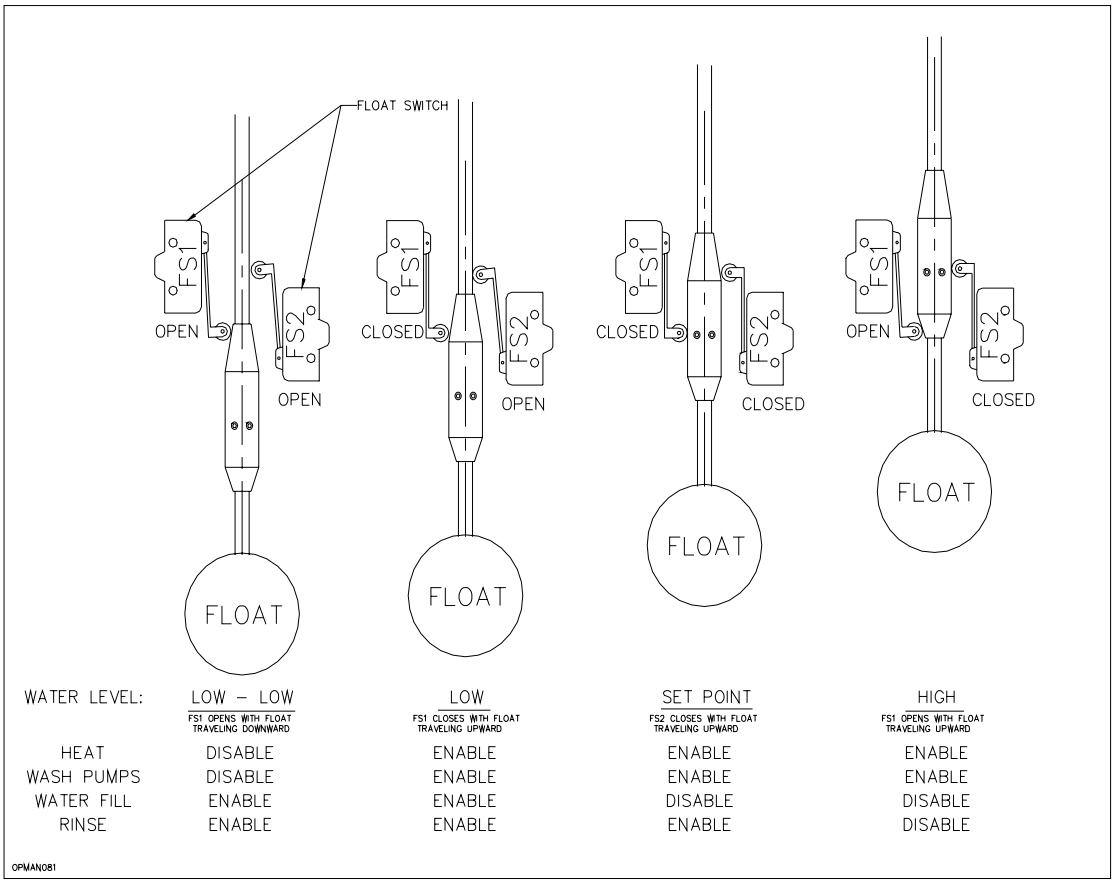


Fig. 1 - 4: Float-Level Mechanics

The ***rinse-bank*** is the amount of space available in the reservoir for additional rinse water. Since the water-fill system only fills to the SET POINT, the ***rinse-bank*** allows accumulation of available rinse volume during:

- Wash cycles
- *Between* wash cycles
- Parts loading *and* unloading
- Heat-up
- Overnight

This allows longer rinses than would be possible with a simple single set-point/water-fill and rinse system:

- With the single set-point system, only water evaporated or discharged from the machine cabinet during a cleaning cycle makes room for rinse water.

- With the rinse-bank system, by contrast, any time water is evaporated or removed (via drag-off) it increases the ***rinse-bank***. This water permits *longer* rinse cycles and is available for *added* rinse time.

The following figure shows the water level dimensional differences between each water-level position detected by the float system *(Low-Low*, *Low, Set-point, High)*:

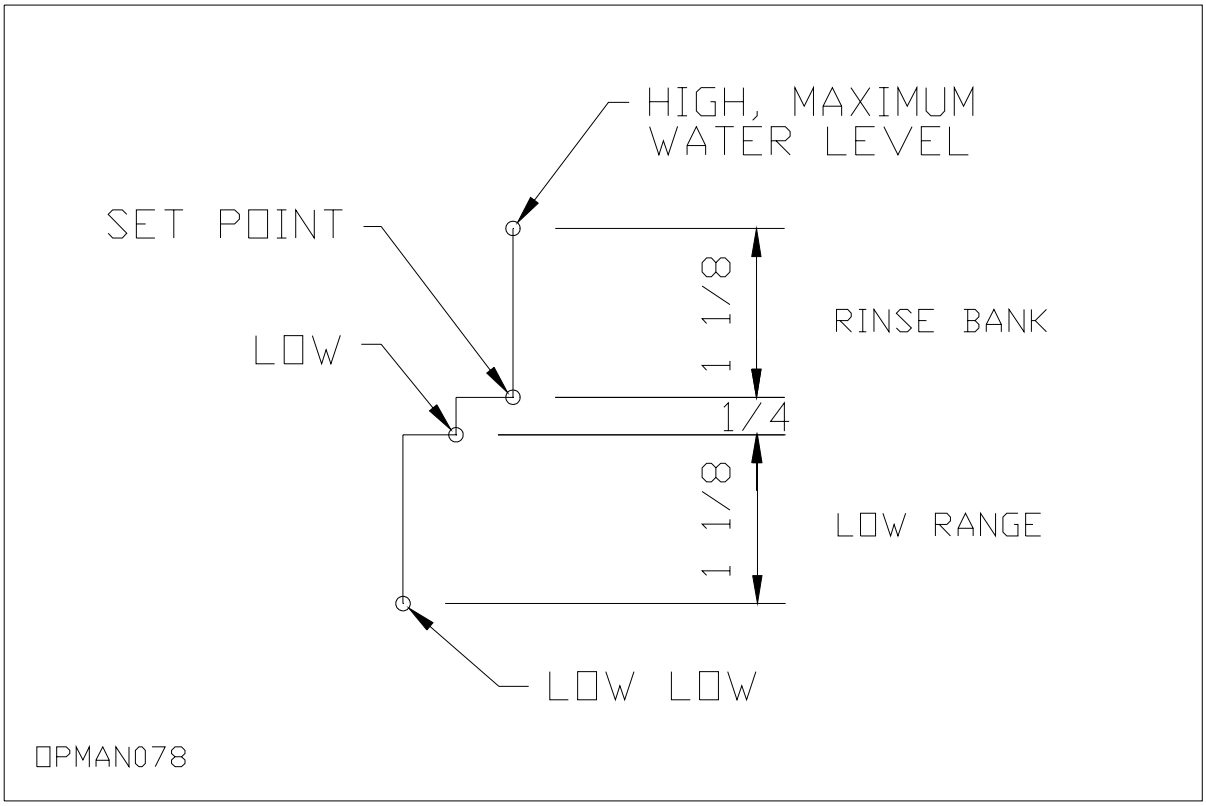


Fig. 1 - 5: Water Level Differences at Four Positions

3.2.9. Power Washer Control System

This section discusses the power-washer control system and sequence of operation when powered up for a wash cycle. Operator controls are located on the outside of the (electrical) control panel, to the left side of the door. Major system controls are housed inside the electrical panel. A number of system features are logically interdependent, in order to help ensure safe operation of the washer.

This section is divided into the following parts:

- Operator controls
- Major components
- Sequence of washer operation
- Interdependent system features
- Electrical schematics

See chapters on "*Installation"* and *"Advanced Operations: Process-Control"* for more detailed information on using the control system.

Operator Controls

The operator uses these controls in day-to-day wash-cycle operations. They are located on the outside of the (electrical) control panel, to the left side of the door, and include:

Hour Meter	Monitor the total number of hours of washer cycle time for scheduled maintenance procedures, from *start* to the *end* of cycle.
Rinse off/auto	set the rinse switch to *AUTO* to enable the rinse cycle; OFF bypasses the rinse cycle.
7-Day Dual-Circuit Clock	Program heat-up days and start/stop times for heat and water-fill; program circuit #2 to control the "auto" runtime for the optional Clean Machine or Oil Skimmer.
Wash Cycle Timer	Set 0-30 minute wash cycle
7 Day Clock	Select *BYPASS* to override the 7-day clock. Select *ON* to enable the 7-day clock control.
Turntable Jog	Press the *TURNTABLE JOG* button to rotate the turntable for easier loading/unloading.
Start (Run Light)	Press the *START* button all the way to begin the wash cycle. The green run light illuminates indicating cycle running. **Note**…The start circuit is interlocked with the door closed limit switch. The opening and closing of the washer door resets the start circuit.
Stop/*Reset*	Press the *STOP* button to stop washer operations (heat source and water-fill functions are not affected). The green “Run Light” extinguishes indicating cycle terminated.

NOTE: If you have purchased any options, such as the Clean Machine, Oil Skimmer, or Conductivity Controller, their operator controls will appear on the control panel, if applicable. Refer to chapter *"Options"* for more information.

NOTE: If you specified any custom features, your control panel may differ slightly from the standard panel. For example, your wash timer may be located inside the electrical control panel. If you requested a *water fault indicator*, it illuminates only if the water level falls below operational requirements.

For more detailed information on operator controls and their usage, refer to chapter *"Basic Operations."* For more information on installing, operating, and maintaining options, refer to chapter *"Options."*

Major Components

The power washer is delivered with a factory pre-wired control transformer. It automatically reduces line voltage to single-phase 120 Volt AC control voltage.

Controls inside the electrical control panel are used to set up basic washer operating logic. These controls include:

- Timers and relays that control the cycle logic
- 7-day clock
  A programmable device that allows the operator to preset the days of the week and time of day for the washer to heat up. The clock also allows the operator to set the days of the week and time of day when the washer is in normal "shut-down" mode. In conjunction with "shut-down" mode settings, the operator can, for example, set the controls to begin automatic operation of skimmers and the optional Clean Machine, based on clock "end-of-day."
- Motor starters with overloads
- Fusing

Sequence of Washer Operation

When a wash cycle begins, the following sequence of operation occurs automatically:

APE/Wash-Delay *Single Pump - larger than 10 HP only*: The adjustable wash delay timer activates and opens the compressed-air solenoid valve for 0-1 minute, depending on your timer setting. This forces compressed air into the solution reservoir, causing a jet of steam to fill the wash cabinet. Then the timer activates the main wash-pump circuit.

Or

Duplex Pumps only: The booster pump starts first and pre-heats the air for 0-1 minute, depending on your wash-delay timer setting. Then the timer activates the main wash-pump circuit.

Wash Pump the main wash pump motor *starter* engages, activating the main wash pump motor. The power blast manifold (PBM), the turntable drive motor and the auto steam exhaust (ASE) blower motor also start. This begins the wash cycle. When the 0-30 minute wash cycle timer times out, the wash pump starter and power blast manifold (PBM) stop operating. This ends the wash cycle.

Rinse System *(optional)* The rinse solenoid opens, and the auto rinse cycle (ARC) begins. When the ARC timer times out, the rinse cycle has finished. The turntable drive motor stops.

ASE Blower Motor After the rinse cycle has finished, the auto steam exhaust (ASE) blower motor continues, until the ASE timer times out, ending the ASE cycle.

Interdependent System Features

Some washer system features are linked to others, in terms of control logic. Here is a list of principal interdependent features:

Door-Limit Safety Switch: The loading door must be shut before the wash cycle can begin.

Door-Limit Safety Switch verification: The door limit switch is interlocked with the start circuit, which verifies the proper operation of this switch. Opening and closing the wash door resets the start circuit allowing a wash cycle to begin.

Water and Heating System ON: The heating system functions *only* if there is sufficient water in the washer to activate the circuit. See *"Water-Level Control System"* section above.

Makeup Water and Rinse System ON: The rinse system functions *only* when there is a need for makeup water, or when the ***rinse-bank*** is low. See sections *"Water-Level Control System"* and *"Automatic Rinse System (ARC)" above*.

7-Day Clock and Heating System: The 7-day clock controls daily heating periods, *unless* the operator uses the clock-override switch to bypass the 7-day clock.

Wash Pumps and Start-Up System: Air in the cabinet is pre-heated in order to prevent rapid expansion (water hammer) when the wash pump comes on. How this works depends on whether you have a single-pump or a duplex-pump system.

Single-Pump System: All 20-, 30-, and 40-horse power systems have an APE (Automatic Pressure Equalization) unit that starts first and pre-heats the air for 0-1 minute, depending on your wash delay timer setting. Then the timer activates the main wash-pump circuit.

Duplex-Pump System: The booster pump starts first and pre-heats the air for 0-I minute, depending on your wash delay timer setting. Then the timer activates the main wash-pump circuit.

WARNING! Do not disable the APE (automatic pressure equalization) wash-delay timer! -- Water hammer could occur, resulting in severe damage or injury!

Electrical Schematics

Please refer to the electrical schematics provided with your washer.

4. Washer Inspection

When you receive your new MART Power Washer, inspect it for freight damage -- ***Do this before installation!***

Here are some tips:

Inspect:		***For:***
Entire cabinet, including the top	➔	*dents or scrapes*
Electrical wire conduits	➔	*breakage*
Cabinet door	➔	*dents or scrapes; Misalignment*
Water hoses and pipes	➔	*breaks or cracks*
Solenoid valves	➔	*breakage*
Electrical control panel door	➔	*dents and scrapes*
Motors	➔	*damage*
External gauges	➔	*damage*

Fig. 1 - 6: Washer Inspection before Installation

Record any damage on the bill of lading.
Report any damage to MART.

2 Installation

Purpose

This chapter gives operating instructions/procedures for installation and startup of the *MART Power Washer*. Correct installation of the washer is important for the following reasons:

- To ensure that the washer will function properly.
- To ensure that placement of the washer on your shop floor will fit into the workflow pattern.
- To ensure that you have a valid warranty.

Prerequisites

Before you begin to install the power washer, be sure you have followed the recommendations in this section.

- ❑ **Information**: Read the entire manual before installation.
- ❑ **Expert Help and Equipment**: For leveling, anchoring, installing, and startup have the following on hand:
  - Qualified, trained personnel
  - Proper lifting equipment
  - Anchoring materials
  - Steel shims
  - Flue pipe
  - Auto steam exhaust (ASE) pipe
  - Rain cap(s)
  - Tools, including masonry drill
  - Voltmeter and amp meter
- ❑ **Steam-Exhaust PVC Kit**: Order your kit through MART. Refer to section *"Steam Exhaust (Output)"* in this chapter.

- ❑ **1/2-inch NPT water regulator**, *if* your water pressure is greater than 125 PSI (862 kilopascals).

- ❑ **Air Filter and Regulator**: 1/2-inch NPT size. (You will need this only if compressed air is required for your washer.)

- ❑ **Placement Planning**: Refer to your *Services to be Provided by Others and Service Requirements (SBO)* letter from MART for specific utilities required for your power washer, and its overall dimensions. Here is a checklist to use as you plan placement:

  - ❍ *Route*: Plan the route you intend to use to move the washer from the loading dock to its installation location. Refer to the SBO for the washer's overall dimensions and weight. Be sure the washer will fit through all doorways.

  - ❍ *Maintenance and Service Access*: Leave enough access room around the washer in the installation location to reach all system components for maintenance and service, especially the pump area (pump removal). Allow for cleanout with the door in full-open position (180° angle from the cabinet doorframe).

  - ❍ *Operations Access*: Leave adequate room to work with the washer during normal operations. Allow sufficient room for loading and unloading the washer with the door in a half-open position (90° angle from the cabinet doorframe).

  - ❍ *Overhead*: Allow for easy installation of flue pipes and steam-exhaust pipes. Be sure the area is clear of overhead shop equipment. Plan for the shortest and most direct run, to avoid needing a larger steam-exhaust motor or more complex piping.

  - ❍ *Roof*: If you intend to run the steam-exhaust and gas flue pipes through the roof, be sure this is feasible. Plan for the shortest and most direct run, to avoid needing a larger steam-exhaust motor or more complex piping.

    Ensure that flue-pipe clearances from combustible material are in accordance with NFPA or the flue manufacturer's instructions.

  - ❍ *Utilities*: Check how far utility sources are from the washer -- gas, fuel oil, water, compressed air, and electricity. Plan for the *exact* route you intend to use -- the shortest and most direct run -- to avoid complex wiring and piping.

    CAUTION! Do not ever run conduits to the control panel over the pump motor.

  - ❍ *Combustion Air:* If you have a combustion-type burner as a heat source, ensure there is an adequate supply of combustion air in

the area in which the burner is located to assure complete combustion at all times.

If the power washer is installed in a room by itself, the room should have its own combustion air supply. This should take the form of louvers through an outside wall, or, if the room is in the center of a building, properly sized ductwork to a source of outside air.

If the power washer is located in a large open area of a plant, it will normally draw its combustion air from inside the plant. However, problems may arise if there is an imbalance between exhaust and makeup air in the plant.

Refer to the latest issue of the *National Fuel Gas Code* (American National Standard ANSI Z223.1) for details. In general, it specifies that a permanent opening or openings having a total free area of not less than 1 square inch (2.5 sq. cm) per 4,000 BTU per hour total input rating of all appliances is required.

- *Floor*: Plan to set the washer flat on the floor, so that it can be anchored for safe door loading.

- *Options*: If you have ordered optional equipment, such as the Clean Machine, allow adequate space in the washer area. See chapter *"Options"* in this manual for more information on any options you have purchased.

- *Grounding -- Electrical:* Plan for a grounding system to reduce the risk of electric shock.

- *Earthground -- Corrosion*: Plan for an earthground to prevent corrosion.

Results of Correct Installation

If you plan the placement of your washer and follow other MART-recommended installation procedures, you should achieve the following results:

- A safe installation
- Proper accessibility to the washer for operations and maintenance
- Proper and efficient functioning of all utilities
- Proper functioning of all cycles, according to specifications
- Assurance that your warranty is valid and in effect

Safety/Precautions

Before you begin installation, read and follow these recommended safety/precaution instructions.

CAUTION! GROUNDING INSTRUCTIONS: The washer must be grounded! Grounding provides a path of least resistance for electric current, thus reducing the risk of electric shock during maintenance, troubleshooting, or repair.

CAUTION! GROUNDING INSTRUCTIONS: The washer must be connected to a grounded, metal, permanent wiring system; OR an equipment-grounding conductor must be run with the circuit conductors and connected to the equipment-grounding terminal or lead on the washer.

WARNING! IF YOUR POWER WASHER USES A GAS BURNER: If you do not follow installation and operating instructions exactly, a fire or explosion may result, causing loss of life, personal injury, or damage to property. Do not store or use gasoline or other flammable vapors and liquids in the vicinity of the Power Washer.

WARNING! VENTING OF EXHAUST GASES: Do NOT vent exhaust gases into a wall, a ceiling, or a concealed space of a building. Refer to the instructions in this chapter for correct vent installation instructions.

WARNING! Be sure that the people installing the equipment and the power washer are qualified and trained for the task. They should meet any licensing standards required in your area.

WARNING! Set up your power washer installation to conform to all local code requirements.

WARNING! Do NOT add water, chemical, or turn on the power during installation! These steps are part of the startup procedure: Wait until "Startup Procedure," at the end of this chapter, to add water, chemical, or turn on the power!

WARNING! The power washer is designed to be installed inside a building, not outside.

What You Will Learn In This Chapter

In this chapter you will learn the following about installing the washer:

- Lifting and moving
- Placement
- Unpacking
- Leveling and anchoring
- Services and connections
- Startup procedure
    * Power-up
    * 7-Day clock initialization

1. Lifting and Moving

After you have planned the placement of the washer and selected a suitable site, use one of the following methods to lift and move the washer:

1. Use a **forklift** *only on the washer base frame* to lift and move the washer. ***Note***: You may also use **machinery rollers**.

Or

Use a **crane** to raise the washer by the *lifting eyes*, located on the top left and top right sides of the cabinet, as shown in FIG. 2-1.

WARNING! Use lifting equipment rated for the weight of your power washer. To find out the weight, refer to the MART Power Washer specification section in the* Services to be Provided by Others and Service Requirements (SBO) *letter that you received from MART.

WARNING! Lift the washer by the lifting eyes only. DO NOT attach chains or cables to a central point, or the sidewalls and roof of the cabinet may collapse. Use a spreader beam to divide/spread the vertical load to each eye.

WARNING! Stand clear of the washer during lifting and moving.

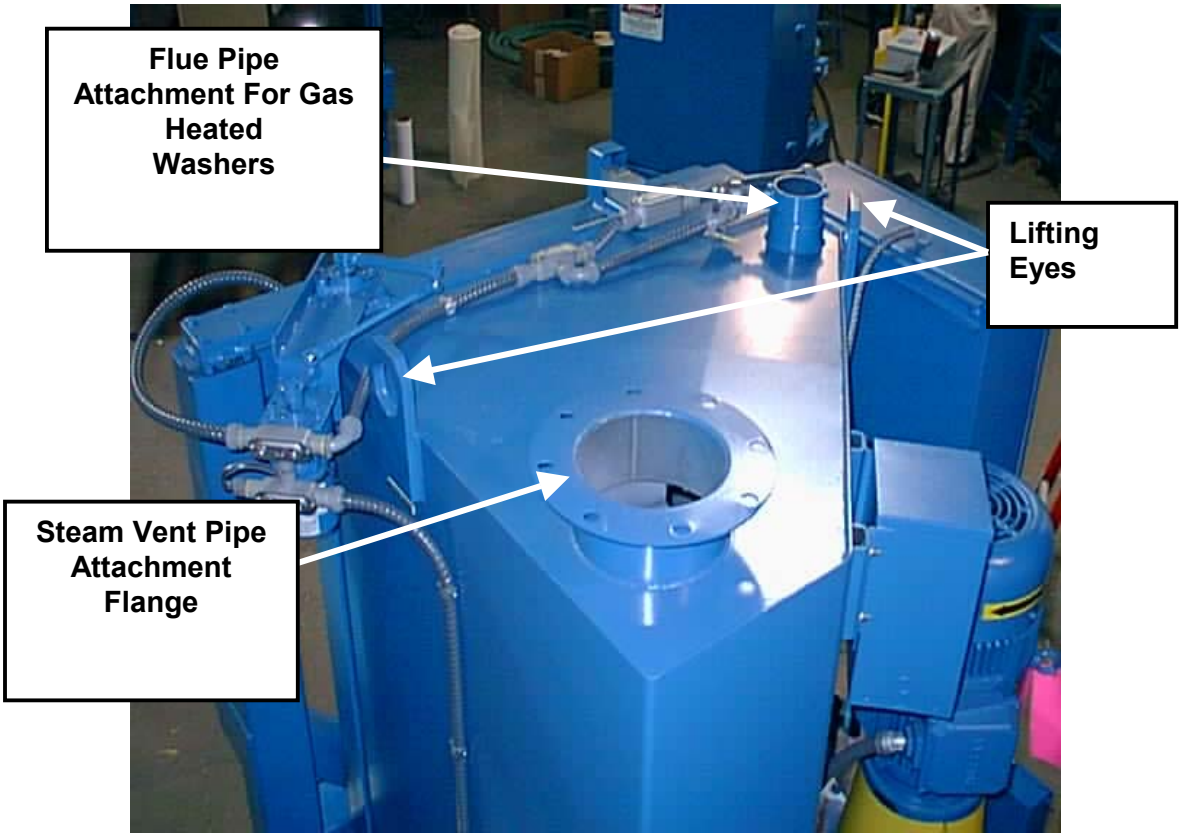


Fig. 2 - 1: Raising the Power Washer by the Lifting Eyes

2. Placement

After you have moved the washer to the installation location, place it according to your plan. Watch the overhead and side areas around the washer as you place it. Walk around the washer and verify clearances.

Refer to section *"Prerequisites, Placement Planning"* at the beginning of this chapter for placement guidelines and recommendations.

You may want to jot down special placement notes here as you plan:

3. Unpacking

After you have placed the washer in the installation site, unpack it. Check the packing slip (attached to the washer) to see *what* to look for.

Note: Most items and accessories are shipped in the washer cabinet on the turntable.

Follow this general procedure:

1. Remove the packing material from the outside of the washer cabinet.

2. Unlatch the cabinet door and open door slowly and carefully.
   Note: Some items secured to turntable may have shifted during shipment.

3. Remove the cartons strapped to the turntable.

4. Check all standard items, accessories, and documentation against the packing slip. Refer to Fig. 1-1 and Fig. 1-2 to identify major components.

5. Open the electrical control panel. In a pocket on the inside of the door you should find the following:
   - Vendor cut sheets and manuals
   - *Field Startup Procedure (FSP)* form
   - SBO (Service By Others)
   - Electrical Ladder Diagram
   - Washer Manual
   - BOM (Bills Of Material)
   - Cover Letter
   - Sample Warranty

6. Look on the outside of the electrical-control-panel door to find the service schedule.

After you have moved, placed, and unpacked the washer you are ready to perform the following parts of the installation process:

- **Leveling and anchoring**
- **Connection procedures**
- **Services and connections verification**
- **Startup procedure**

IMPORTANT! Before you go any further, get the *Field Startup Procedure (FSP*) form (it is in a pocket on the inside of the electrical-control-panel door). You will use the form as a checklist to ensure correct installation as you follow the steps in the next several sections.

Use the Field Startup Procedure (FSP) *form in this way*:

1. As you install the washer, fill in the *Field Startup Procedure (FSP)* form.
2. After you have completed a successful installation, sign and date the form.
3. Make 1 copy and keep for your records. Mail/FAX to MART the other copies being sure it is properly signed and dated.
4. Keep your copy in your maintenance records. You will need it during maintenance procedures, and any time you call MART.

NOTE: Information gathered on the **FSP is critical** in verifying initial performance and in providing a benchmark for future diagnostic and troubleshooting efforts! ***Be sure to fill in the FSP during installation!***

4. Leveling and Anchoring

The power washer should be placed on a flat floor suitable for "anchoring" the washer. For example:

- Concrete floor
- Concrete pad
- Steel structure

4.1. Leveling

Follow this procedure:

1. Find the leveling and anchoring feet (at each corner of the washer at floor level).

2. Find the leveling bolt/nut and the anchor hole on each leveling and anchoring foot. Refer to the following figure.

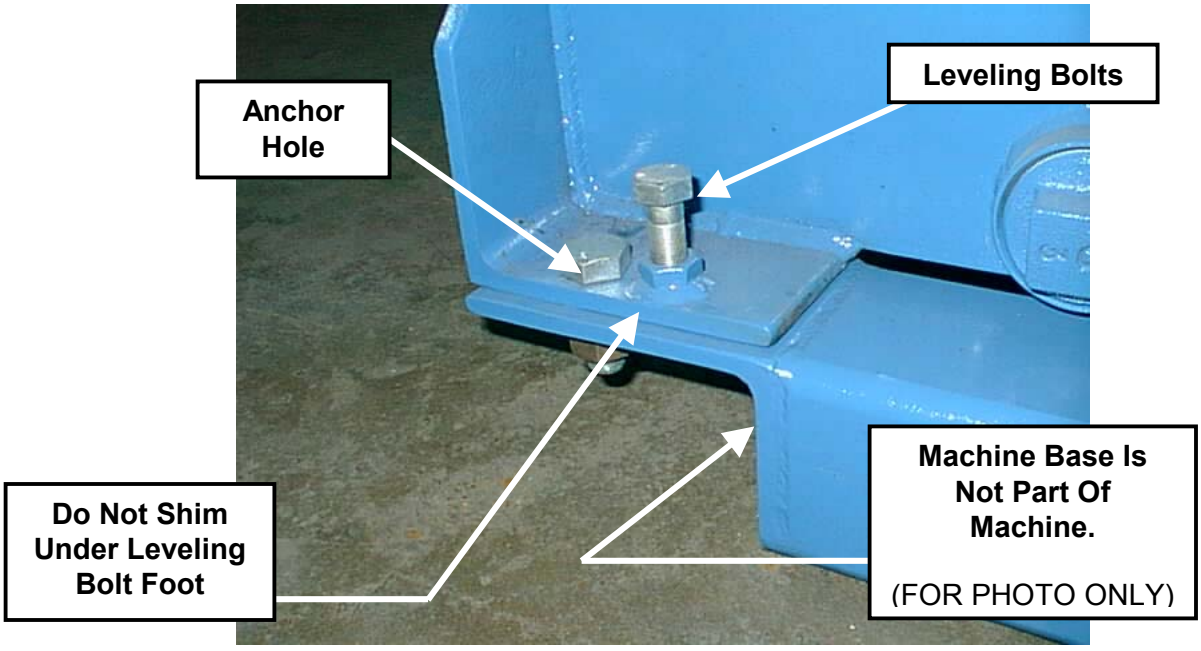


Fig. 2 - 2: Leveling and Anchoring Feet

3. Adjust the leveling bolts so the cabinet door will stop and remain in any open position with minimum "creeping" to a more open or closed position. Do **NOT** level the machine using a bubble level on the reservoir or other part of the machine.

   Turn the leveling bolt *clockwise* to *raise* the corner of the cabinet. Turn the leveling bolt *counterclockwise* to *lower* the corner of the cabinet.

4. After leveling, ***shim under the frame*** of the washer, so that the washer frame is supported by the shims, *not* by the leveling bolts.

> ***WARNING! Do not shim under the leveling/anchoring feet. This will interfere with the leveling bolts. Shim under the frame of the washer only.***

5. When the washer is level and the shims are in place, back off the tension of the screws on the leveling bolts, so that the washer rests solidly on the shims.

6. Re-check the door to be sure it does not "creep." If it does, repeat the leveling and shimming procedure.

4.2. Anchoring

After you have properly placed, leveled, and shimmed the power washer, anchor it to the floor.

Follow this procedure:

1. Use the anchor holes provided on each leveling/anchoring foot.

2. Use bolts whose diameter equals the diameter of the anchor holes.

3. Anchor the bolts solidly and completely into the floor, so that each bolt can carry its full tensile strength. (MART recommends an epoxy-injection bolt-anchoring system.)

4. Consult your local distributor of anchoring products for an anchoring system that meets your requirements.

5. You may wish to grout the washer's base angle. If so, keep the following in mind:

   Grouting is designed to fill the area between the base angle and the concrete -- permanently and completely -- and securely bond the base angle to the concrete. However, grout is not "glue," nor does it do the work of the anchor bolts. It is meant to provide vertical support and absorb operating forces. Additionally, grout seals the base angle to the floor, so that water and moisture cannot get under the washer and cause corrosion.

   When placing grout, follow the manufacturer's detailed instructions to the letter! This will help prevent voids and other grout-repair problems later.

   In general, use only *non-shrink grout*. The distributor should be able to tell you whether the grout has been tested for shrinkage, before and after hardening. And remember that most epoxy grouts require bone-dry concrete.

   For example, for concrete flooring, MART recommends an epoxy grout. To test for dryness of concrete, tape a rubber mat or plastic sheet to the concrete; check for condensation after 24 hours. Don't apply the epoxy if there is any moisture.

   Your distributor should give you the *manufacturer's detailed instructions* for:

   - Preparing the base angle
   - Equipment needed
   - Mixing the grout
   - Application

5. Services and Connections

Begin services and connections *only after* you have leveled and anchored the washer.

5.1. Introduction

You are now ready to connect the utilities to the washer, and install options. To do this, use your utilities connection plan, devised during placement planning. (Refer to section *"Prerequisites, Placement Planning"* at the beginning of this chapter.)

Your plan and the SBO tell you which of the following utility connections and options' installations you must make. Use this manual to locate the connections on the power washer.

> ***WARNING! Be sure that the people who install the power washer and make connections are qualified and trained for the task. They should meet all licensing standards required in your area.***

Utility connection procedures are divided into two major parts:

- Input
- Output

These are discussed in the sections that follow.

After you have connected utilities, install any options you may have purchased from MART.

5.2. Connection Procedures - Input

This section describes *input* connection procedures. The next section describes *output* connection procedures.

Use your placement plan and the SBO form to determine which of the following utility connections you must make.

Input Utility Connections:

- Heat source
    - Gas (natural and propane)
    - Electric
    - Steam
- Water
- Compressed air
- Electricity

Depending on your power washer configuration and optional equipment, refer to the applicable sections in this manual for information on making the necessary connections.

5.2.1. Heat Source

Depending on the washer's configuration and options, it will use one of the following heat sources:

- Gas (natural and propane)
- Electric
- Steam

A description of each type of heat source follows.

Gas & Oil Heat Source

For proper connection of the gas heat source, natural or propane, refer to the specifications in the SBO and to the vendor manual provided with the burner.

Burner Mounting

The power washer is equipped with a burner, as shown in one of the following figures. Locate the figure that refers to your burner size. **NOTE:** After burner mounting is completed, check to be sure there is an airtight seal between the burner and the combustion chamber.

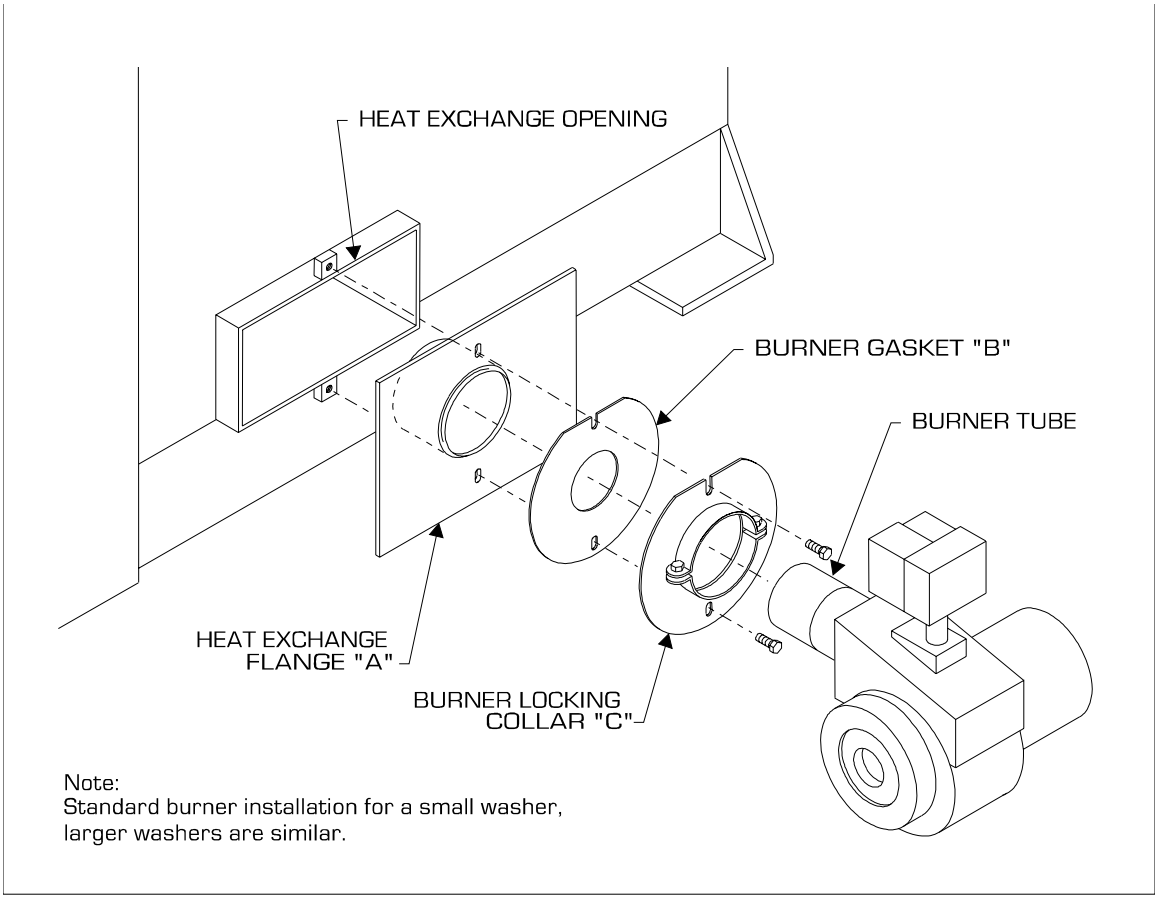


Fig. 2 - 3: Mounting the Combustion Burner (Up to 180,000 BTU)

For combustion burners up to 180,000 BTU, *follow this procedure* (refer to the previous figure):

1. Attach:
   - *Heat exchanger flange A*
   - *Burner gasket B*
   - *Burner locking collar C*

   to the *heat exchanger opening* located on the right side of the washer. Use the *mounting bolts* provided.

2. Insert the *burner tube* into and through:
   - *Burner locking collar C*
   - *Burner gasket B*

   to the *stop block* welded into the *heat exchanger flange A*.

3. Tighten the *burner-locking collar C* around the *burner tube*.

Now go to the *"Burner Fuel and Electrical Connection"* section.

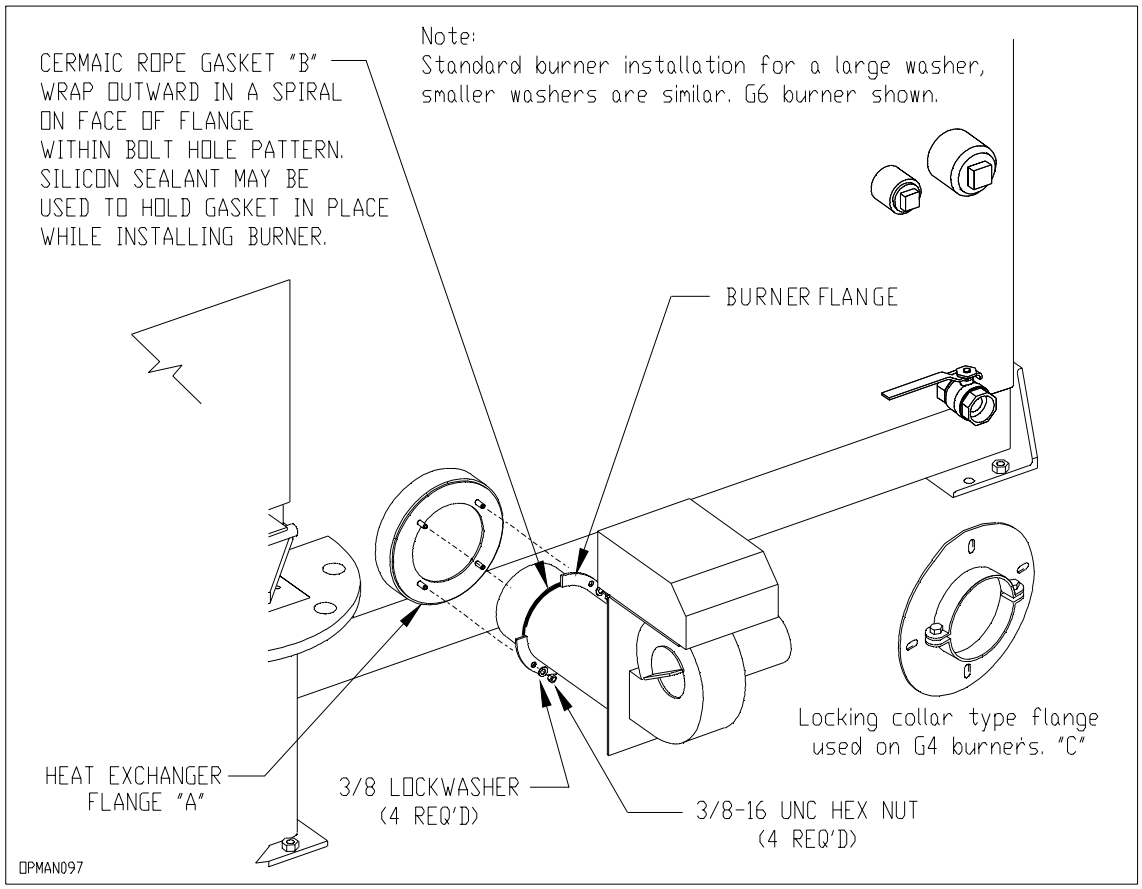


Fig. 2 - 4: Mounting the Combustion Burner (Up to 400,000 and 800,000 BTU)

For combustion burners up to 400,000 BTU and 800,000 BTU, *follow this procedure* (refer to the previous figure):

1. Install the ceramic-fiber rope gasket supplied with the burner: Wind it in a spiral on the face of the burner flange, inside the bolthole circle, in a single layer. Cut off the excess rope. **NOTE:** The rope may be held in place by masking tape or RTV adhesive.

2. Insert the burner nose into the end of the heat exchanger. Align the boltholes.

3. Install 4 burner mounting bolts. **CAUTION:** *Do NOT over-tighten these bolts to the point where the burner flange distorts!*

Now go to the *"Burner Fuel and Electrical Connection"* section.

Burner Fuel and Electrical Connection

For all combustion burners, *follow this procedure:*

1. Locate the *unconnected 1/2-inch (13-mm) PVC conduit* containing:
   - *One orange wire*
   - *One white wire*
   - *One green wire*

   and install it in the *burner junction box*. (The conduit was secured for shipment to the right side of the cabinet.)

2. Splice the orange, white, and green wires to the wires in the burner junction box as shown in the following figure. (Please note that for Riello Burners the orange wire lead connects to L , the white wire connects to N, and the green wire connects to the green ground screw in burner junction box. For Gordon Piatt burners the orange wire connects to #1, the white wire connects to #2, and the green wire connects to the green ground screw in the junction box of the burner.)

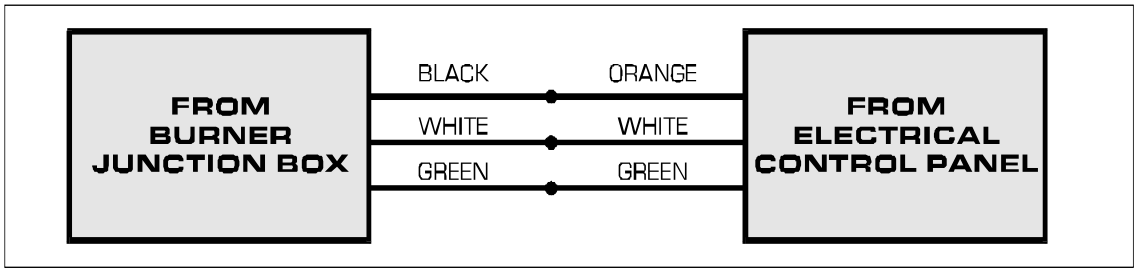


Fig. 2 - 5: Burner Junction Box -- Wiring

3. ***(Gas)*** Connect the gas supply pipe to the *combination gas valve inlet* (natural or propane gas). **NOTE:** Larger burners have a separate gas train that you must connect to the burner *before* connecting the supply pipe to the inlet.

Note: Be sure the gas supply line is of adequate size for the firing rate of your burner and for the length of the gas pipe supply run. Refer to the gas burner vendor manual for information on pipe capacities versus run lengths.

Or

(Oil) Connect the *fuel-oil supply tube* to the *fuel-oil pump inlet*.

WARNING! Refer to your fuel-oil burner manual to determine if a fuel-oil return line is required.

WARNING! Do not allow gas pressure in excess of 12.0 WCI to be applied to the combination gas valve inlet, or damage may occur. If gas pressure in the branch line supplying the burner is above 12.0 WCI, then a lock-up type gas pressure regulator of the correct size and range MUST be installed.

4. Turn *ON* the *main gas supply*.

WARNING! Do NOT try to start the burner at this time! NEVER operate the burner unless the washer reservoir is at "full-water" level. You will start the burner later, during the startup procedure.

5. Perform leak tests at all fuel pipefittings and joints, including all connections on the burner, and all piping installed to the burner. To do this, smear a solution of soap and water around all fittings and look for bubbles. If you see bubbles, the fittings and joints are not tight, and are leaking.

6. Turn *OFF* the *main gas supply.*

Electric Heat Source

The electric heating elements have already been installed at the factory. No further connection procedures are required.

Steam Heat Source

For proper connection of the steam heat source, refer to the specifications in the SBO.

Follow this procedure:

1. Install the *steam solenoid* on the upstream side (the right side of the washer) of the steam heat exchanger, as shown in the following figure.

2. Install the *steam trap* on the downstream side (the left side of the washer) of the steam heat exchanger, as shown in the following figure.

3. Make *connections* to your in-plant steam power system, according to plant and other local codes.

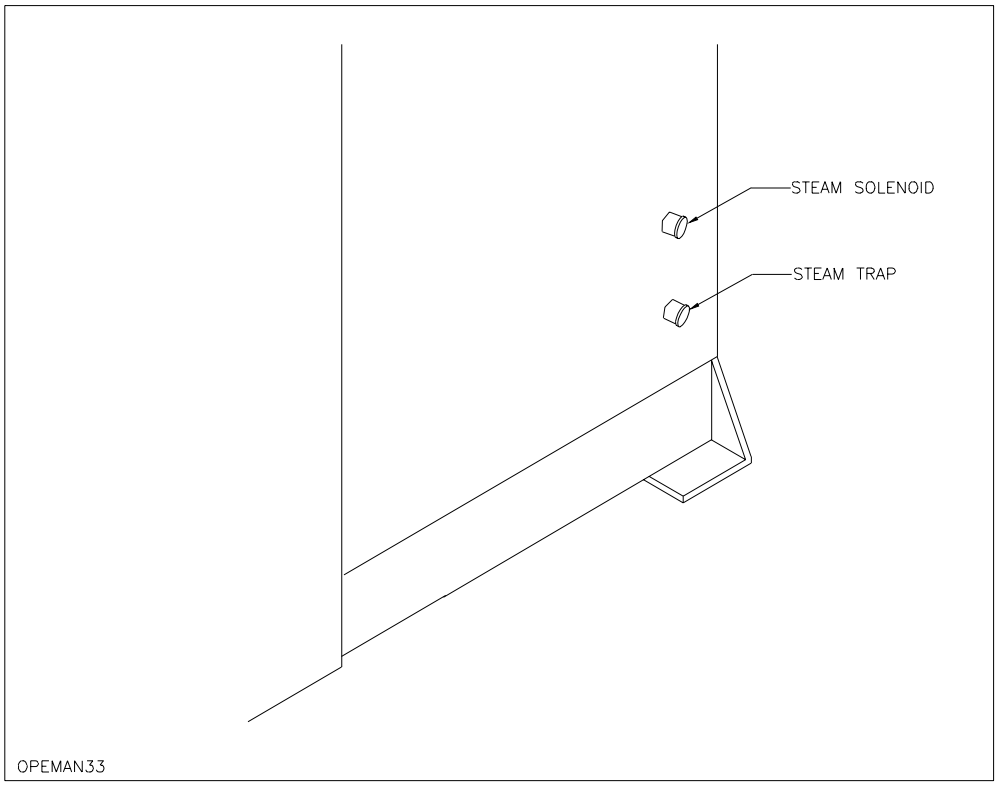


Fig. 2 - 6: Steam Solenoid and Steam Trap Installation

5.2.2. Water (Input)

Refer to the specifications in the SBO form for correct water-line sizes. A 1/2-inch-diameter (13 mm) water line is required for automatic water-fill and the optional Auto Rinse Cycle (ARC).

Follow this procedure:

1. Install a *water regulator*, if incoming water pressure is greater than 125 PSI (862 kilopascals). The regulator should regulate water pressure to 100-125 PSI (690-862 kilopascals). (**NOTE**: The water regulator is *not* provided by MART.)

2. Connect a 1/2-inch-diameter (13 mm) water supply line to the regulator or the washer inlet. NOTE: The washer water supply inlet is a ***BRASS*** fitting. Do not use Teflon tape if you have a plastic filter: use a liquid pipe dope. Refer to the following figure for the connection location.

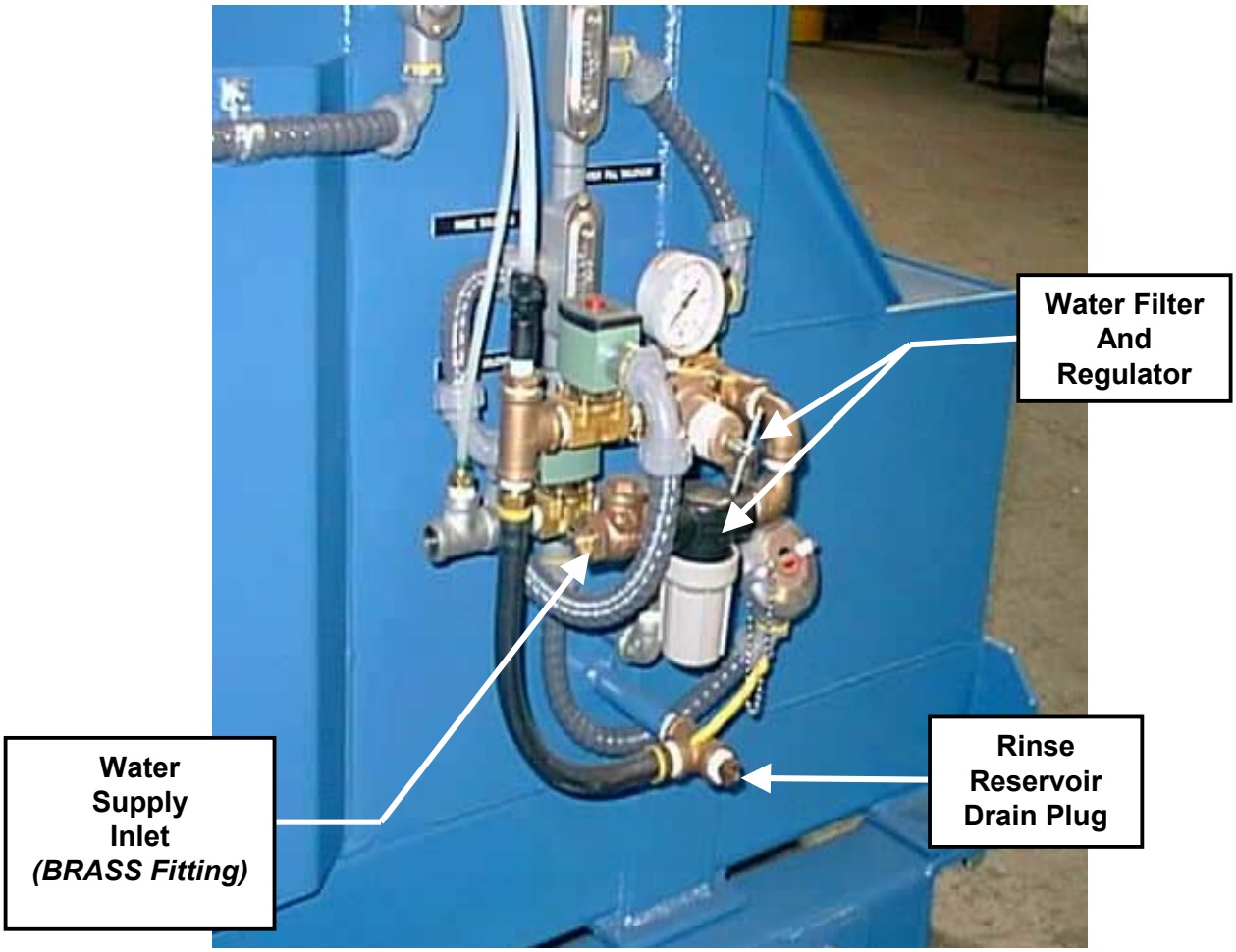


Fig. 2 - 7: Water Connection Location

5.2.3. Compressed Air (Input)

If your washer is equipped with an Automatic Pressure Equalization (APE) unit, you will need compressed air for it. (Single-pump systems smaller than 20 HP and duplex-pump systems do not have an APE.)

> ***NOTE! Do NOT connect a compressed air line to a BRASS fitting on the machine. The compressed air-line connection is a GALVANIZED fitting. If you do NOT have a galvanized fitting you may not need a compressed air line.***

Follow this procedure:

1. Install a 1/2-inch-diameter (13 mm) compressed-air line to the washer. (The incoming pressure range should be between 60-125 PSIG 414-860 kilopascals). **NOTE:** The factory setting for the APE pressure switch is 30 PSI (207 kilopascals).

2. Connect an air filter and regulator in-line with the washer's compressed-air inlet. Refer to the following figure. Note: The compressed air inlet is a ½" ***Galvanized*** fitting.

3. Connect the air-supply line to the filter.

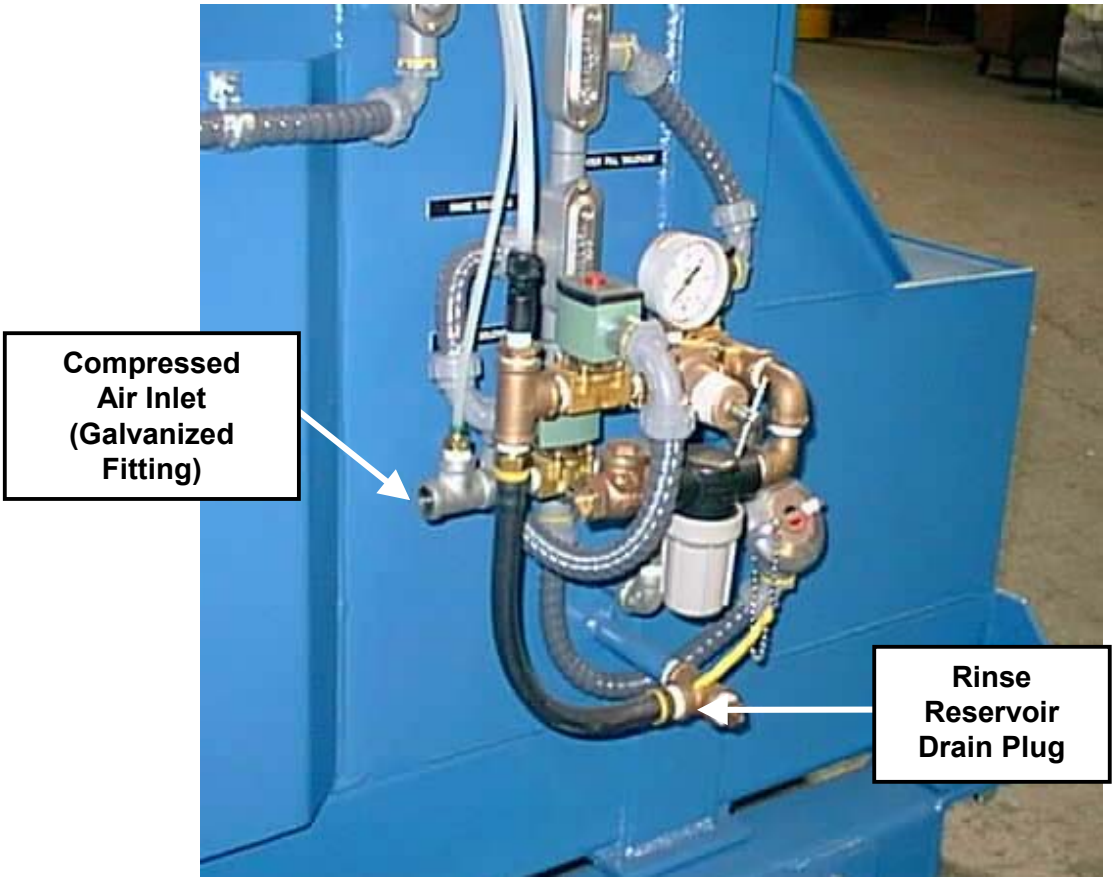


Fig. 2 - 8: Compressed-Air Connection

5.2.4. Electricity (Input)

NOTE: <u>You are responsible</u> for meeting all local and national electrical codes that apply to the power source and to the wiring from the power source to the MART Power Washer. *Be sure that* people who are qualified and trained for the task do all electrical installation and connections*. They should meet all local licensing requirements.*

NOTE: **If your washer is not equipped with a disconnect, NEC *(National Electrical Code)* requires a main disconnect.**

CAUTION! <u>GROUNDING WARNING</u>: The washer must be grounded! Grounding provides a path of least resistance for electric current, thus reducing the risk of electric shock during maintenance, troubleshooting, or repair.

CAUTION! <u>GROUNDING INSTRUCTIONS</u>: The washer must be connected to a grounded, metal, permanent wiring system; OR an equipment-grounding conductor must be run with the circuit conductors and connected to the equipment-grounding terminal or lead on the washer.

<u>Earthgrounding to Prevent Corrosion</u>

The washer must be securely grounded to help prevent stray electrical fields from causing galvanic-type corrosion. Under some circumstances, such corrosion can very quickly cause serious structural damage to the washer (in only several months).

WARNING! Use the proper equipment-grounding circuit per the National Electrical Code Article 250.

The Power Washer must be grounded using a copper conductor. Do ***NOT*** depend on raceways or a conduit as an equipment ground. Install an equipment-grounding conductor connected to the Power Washer's ground lug in the Control Panel *and* connected to your electrical service system ground according to the National Electrical Code Article 250. Use a conductor ***EQUAL or GREATER*** in size to the equipment service conductor to reduce the resistance to ground. A low-resistance path-to-ground is required to minimize galvanic corrosion.

To connect power to the washer, *follow this procedure:*

1. Verify washer *voltage* and *amperage* requirements (in the SBO form).

2. Select a *feeder-wire size* that meets approved *national* and *local code* requirements.

3. Use a ground conductor of ***EQUAL*** *or* ***GREATER*** size (to the feeder wire).

4. Connect *power* from the *main power supply* to the *washer*, following NEC methods. Use proper size *wires* in the conduit, and make watertight connections to the *electrical control panel*.

5. Attach the *feeder wires* to the *power distribution block*, located in the *electrical control panel*. (Refer to the following figure for the location of the power distribution block.)

WARNING! Do NOT turn the main power supply ON at this point!

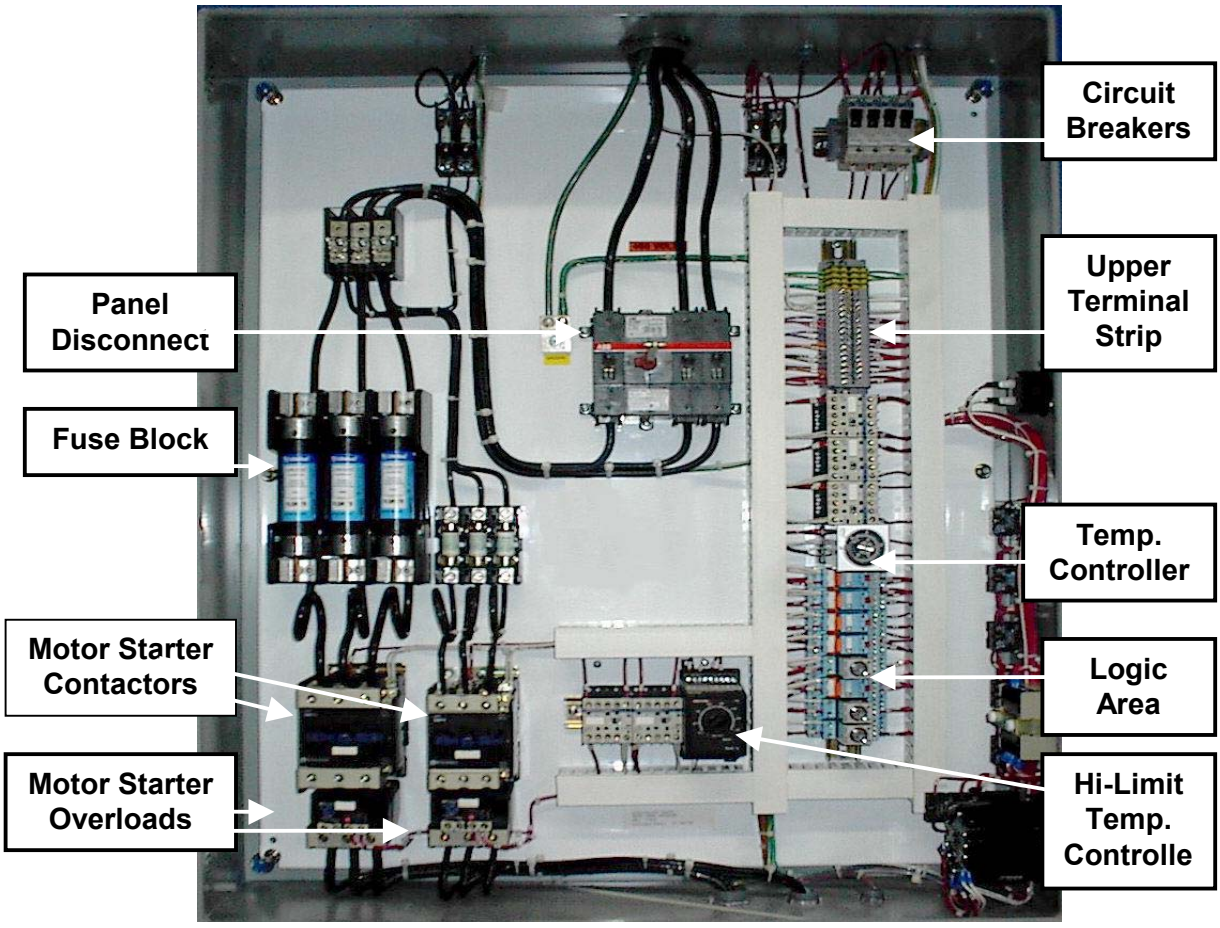


Fig. 2 - 9: General Layout of the Electrical Control Panel (Block Diagram)

5.3. Connection Procedures - Output

This section describes *output* connection procedures. The previous section describes *input* connection procedures.

Use the SBO form to determine which of the following utility connections you must make.

Output Utility Connections:

- Steam exhaust
  - Pipe
  - Fan
- Flue pipe
- Drain

Depending on your power washer configuration and optional equipment, refer to the applicable sections in this manual for information on making the necessary connections.

5.3.1. Steam Exhaust (Output)

For the size of the steam exhaust, refer to the specifications in the SBO.

The following materials can be used for steam pipe:

- **Schedule 40 or 60 PVC pipe** (see *"Prerequisites, PVC Kit,"* at the beginning of this chapter). MART washers are set up for using PVC pipe for the steam exhaust. Your washer and ASE (auto steam exhaust) blower unit arrive equipped for using PVC fittings. **MART highly recommends PVC**, because it is simpler to install, requires no welding, is lighter, and does not rust.

- Schedule 20 or 40 black iron pipe can be used instead of PVC. However, it lacks PVC's advantages. If you opt to use iron pipe, you will need special adapters to modify the flanges on the ASE blower unit.

*The following steam-exhaust **installation instructions assume the use of PVC pipe**.* If you use iron pipe instead, installation steps will be similar to those given here. However, you will have to adapt and modify flanges and fittings as necessary to complete the assembly.

***NOTE:** If your washer is equipped with a hot-air blow-off (HABO) system, refer to that option for special instructions for steam-exhaust installation.*

General installation consists of the following procedures:

1. Install piping.
2. Install the ASE blower unit in piping.
3. Provide rain cap.

> ***WARNING! The steam-exhaust pipe connection must be independent of any other pipe connection. It can not share a steam vent pipe with any other equipment.***

Steam-Exhaust Pipe

Refer to the following figure for the location of the steam-exhaust vent pipe flange. The pipe flange is located on the roof of the washer cabinet for steam vent attachment.

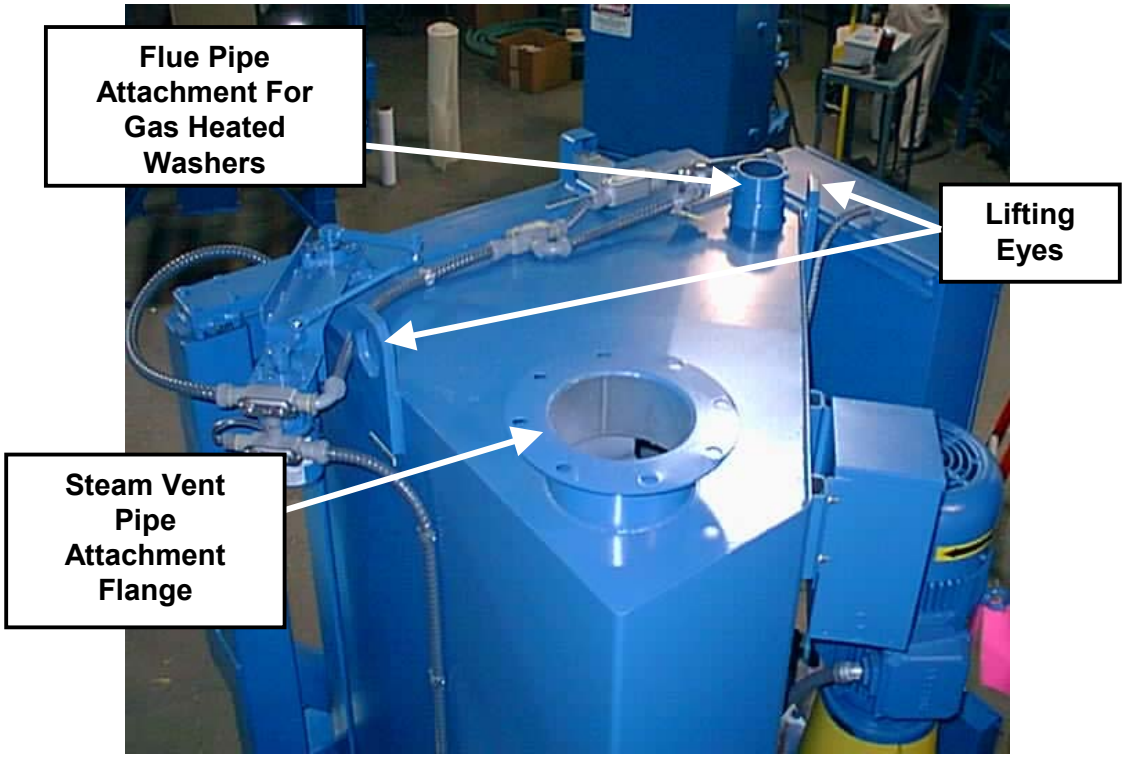


Fig. 2 - 10: Steam-Exhaust Vent Pipe and Flue Pipe Attachments

The steam-exhaust pipe may exit your building either vertically or horizontally, as shown in the following figure. This figure does not show you how to install the ASE blower unit in the piping (see ASE Assembly Figure 2-13) rather, it represents a general view of the two possible configurations (vertical or horizontal). You will select one of these configurations when you install the piping and blower. Note: Install venturi such that fan motor shaft is horizontal. Use a twist transition supplied from MART if required.

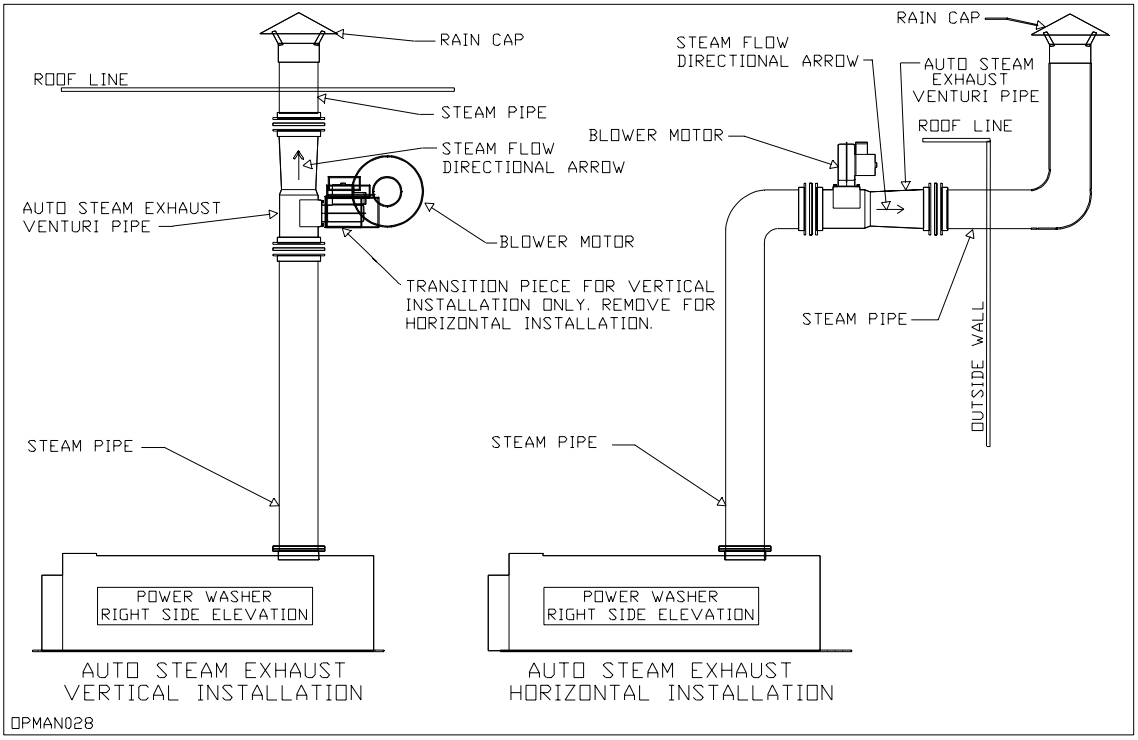


Fig. 2 - 11: Auto Steam Exhaust (ASE) Piping and Blower Installation Configurations

> **Note**: Any horizontal section of steam exhaust pipe must rise by 1/2-inch (13 mm) per foot (30.5 cm) of pipe. This is necessary for proper condensation drainage back to the washer.

Steam-Exhaust Fan

The auto steam exhaust (ASE) Venturi blower assembly is provided by MART. It comes unassembled and must be mounted in the steam-exhaust piping. Mount blower and fan as shown in diagrams. Do not mount fan housing below venturi blower inlet, condensation may collect in blower housing.

Note: The ASE blower assembly comes with a 1/12-HP motor. If your steam exhaust vent pipe exceeds 30 feet (9 m), a 1/4-HP motor is required and can be obtained from MART. If your vent pipe is extremely long, or if there is extreme negative pressure in your shop area, MART may need to assist you in determining the proper size venturi blower and motor assembly. (When calculating pipe length, each 90°-angle bend equals 10 feet [3 m] of straight pipe.)

CAUTION! You must mount the ASE assembly in line with the steam-exhaust pipe, and as far away from the washer as possible, at least 20ft. if possible. – It's best to install where the steam-exhaust pipe leaves the building. Do not install ASE assembly directly on top of the washer!

CAUTION! If you are mounting the Venturi Tube in a horizontal position, mount it such that the fan is above the tube 45° from the vertical, as shown in the following figure.

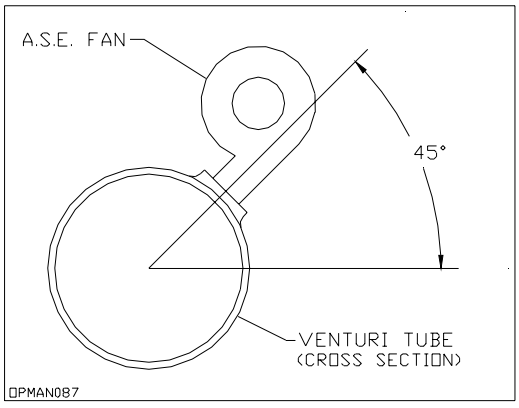


Fig. 2 - 12: Mounting the ASE Fan on a horizontal mounted Venturi Tube

Refer to the following figure for instructions on piping and blower installation.

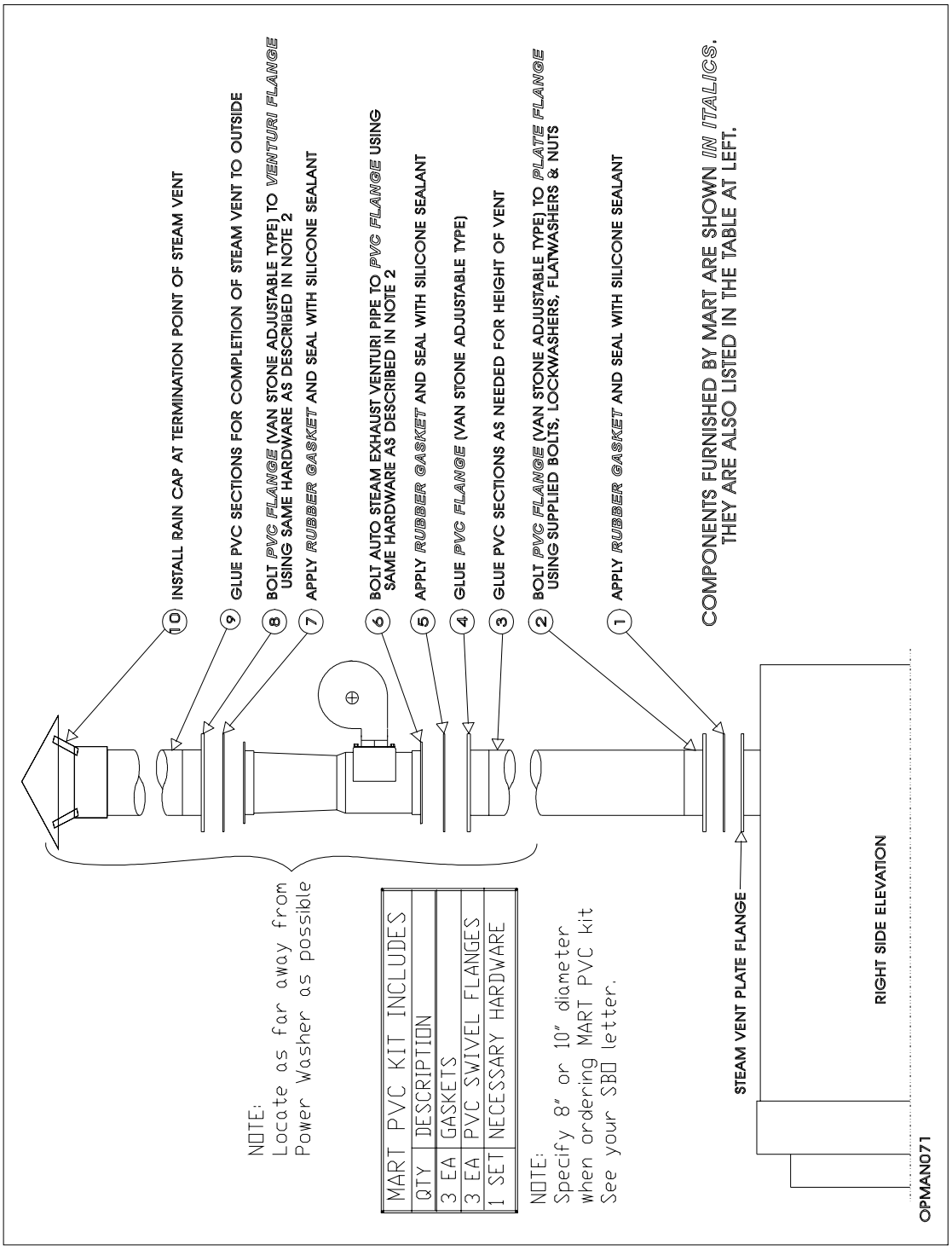


Fig. 2 - 13: Auto Steam Exhaust (ASE) Piping and Blower Assembly

After you have installed the piping and the blower; *follow this procedure to connect the blower to the washer*:

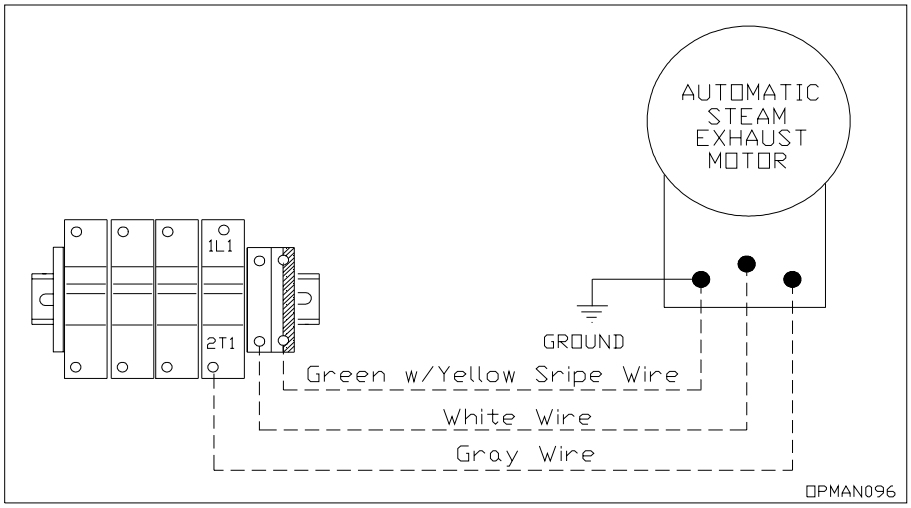
1. Install an approved liquid-tight *conduit* containing *three wires* (red - hot; white - neutral; green - ground; all wires #14-gauge copper, minimum) from the ASE *blower assembly* to the upper terminal block in the Control Panel. (Attach the *three wires* as indicated in the accompanying figure.)

2. Attach one end of the red wire (hot) to the ASE motor circuit protector device located at the top of the control panel next to the terminal blocks. Refer to your machine's panel layout drawing on the inside of the enclosure door for the exact location. Splice the other end of the red wire to one of the black wires on the ASE motor.

3. Attach one end of the white wire (neutral) to an N (Neutral) terminal. Splice the other end of the white wire to the second black wire on the ASE motor.

4. Attach one end of the green wire (ground) to a green ground terminal. Connect the other end of the green wire to a screw on the ASE motor.

NOTE: You must supply the length of wire, fittings and conduit required to extend from the ASE motor to the Control Panel.



Note: The wiring diagram as shown is for the standard 115 volt A. C. motor. If your system utilizes a variable speed D. C. motor please refer to the electrical Schematics supplied with your machine for wiring information.

Fig. 2 - 14: Wiring the ASE Blower Assembly

5.3.2. Flue Pipe (Output)

NOTE: A flue pipe is used ONLY for gas or oil burners.

WARNING! The flue-pipe connection must be independent of any other pipe connection. It can not share a heating-system pipe with any other equipment.

WARNING! Be sure that people who adjust the burner are qualified and trained for the task. Be sure they use appropriate flue-gas monitoring instruments for measuring oxygen, carbon dioxide, AND CARBON MONOXIDE.

WARNING! VENTING OF EXHAUST GASES: Do NOT vent exhaust gases into a wall, a ceiling, or a concealed space of a building. Refer to the instructions in this chapter for correct vent installation instructions.

Flue Pipe installation

Your MART Power Washer is capable of producing exhaust gas temperatures up to 1000 degrees F.

The gas burner flue installation must comply with all applicable local and/or national gas codes for **materials, pipe size,** and **installation** procedures.
Note: (MART recommends a minimum of 16-gauge material for the flue pipe.)

IMPORTANT:
The flue pipe system installed on the MART Power Washer must be sized to create the proper draft during burner firing. The draft required is ± .25 WCI pressure at the flue-pipe stub during burner firing.

Typical installations with an equivalent 10-50 foot flue exhaust run generally will function properly with a flue pipe size 2” larger than the exhaust stub to obtain the required draft pressures of ± .25 WCI at the flue pipe stub.

The MART Corporation does not recommend the use of draft inducers or barometric dampers in a properly designed exhaust system.

To install the flue, follow this procedure

1. Find the *flue pipe attachment* on top of the *washer* cabinet. (Refer to Fig. 2-10 for the location of the pipe stub. On some washers, the flue pipe attachment is by the steam-exhaust pipe attachment.)

2. Route the approved flue pipe from the Power Washer to the outside of the building, taking care to maintain minimum clearances to combustible materials as specified by the National Fuel Gas Code (American National Standard ANSI Z223.1) and other applicable codes.

   Refer to *"Placement Planning/Roof"* at the front of this chapter.

   Note: All horizontal flue-pipe sections must rise a minimum of 1/4-inch (6 mm) per pipe foot (per 30.5 cm of pipe).

3. Be sure the exhaust vent ends in a *vertical* position. The vent termination point must be above the roof peak by the required height as stated by local and/or national codes.

4. Install a *rain cap* at the *end* of the pipe. (**NOTE**: The rain cap is *not* supplied by MART.)

5.3.3. Drain (Output)

A capped drainpipe connection is located on the right side of the washer at floor level.

You may use the drain to hook up the washer to a water-treatment system, or to a pumping system.

However, your washer is easily serviced using a diaphragm pump equipped with a hose and an appropriate strainer. This configuration will allow you to pump solution from the washer into approved containers for disposal according to government codes.

For more information, refer to chapters *"Advanced Operations: Process Control,"* and *"Maintenance"* in this manual.

5.4. Installation of Options

If you have purchased any options with your washer, such as a Clean Machine, refer to chapter *"Options"* later in this manual for information on installation.

5.5. Inspection and Verification

Now you have completed the services and connections required for your washer. Before performing the startup procedure, inspect all services and connections made on the washer during installation. Use the following information:

- *Services to be Provided by Others and Service Requirements (SBO)* letter from MART
- *Field Startup Procedure (FSP)* form

Fill in the *Physical Installation* section of the *Field Startup Procedure (FSP)* form as you inspect what you have done and ensure that all connections have been properly made. During this inspection you will inspect the following items and document your inspection results on the *FSP*:

- Visual inspection
  - Leveling
  - Anchoring
- Physical Inspection of Installation
  - Water Supply
  - Electrical Supply
  - Gas Supply
  - Gas Burner Flue
  - Steam Exhaust

- Check placement and leveling. Fill out the FSP from
- If a combustion burner is used complete “Gas Burner Test “ in the FSP form
- Inspect electrical connections. Fill out the FSP from
- Inspect the ASE assembly. Fill out the FSP from
- Verify your water connection. Fill out the FSP from
- Inspect the drain and pump systems. Fill out the FSP from

Fig. 2 - 15: Services and Connection Inspection

If you note any problems that cannot be solved by making minor adjustments, refer to chapter *"Troubleshooting,"* or call MART.

6. Startup Procedure

A MART factory-trained technician is optionally available to perform startup and customer training. Call MART to request this service. As part of this service, the MART technician will fill in the *Field Startup Procedure (FSP)* form to begin your one-year warranty coverage.

If you perform the startup, training your staff to operate the power washer is your responsibility.

The startup procedure consists of the following activities, in this order:

- Electrical connections inspection
- Lubrication procedure
- Power-up Procedure
  - Preliminary checks
  - Supply Voltage
  - Water Fill
  - Water Level Control
  - Control Voltage
  - Heat – Gas, Electric, Steam, Oil
  - Pump/s Rotation Direction
  - Temperature Control
  - Voltage Readings
  - Amp Readings
  - Water Hammer Test
  - Standard Operational Checks
    - Pump Low-Low Water Shutdown
    - Door Close Limit Switch Operation
    - Heater Low-Low Water Shutdown
- Chemical-charging procedure
- Test-wash procedure

NOTE: Fill in the ***Field Startup Procedure (FSP)* form** as you perform startup. Send it to MART. After it has been verified and accepted, your one-year warranty period will begin. ***This form must be received by MART within 60 days after receipt of your washer!***

WARNING! Be sure that people who perform the startup procedure are qualified and trained for the task. They must follow all procedures exactly as described.

6.1. Electrical Connections Inspection

> ***WARNING! Be sure the electrical power to the washer is turned OFF.***

Open the electrical-control-panel door.

Check electrical connections and components for tightness. Some of them may have loosened during shipping.

Inspect timers and relays in the electrical control panel to be sure they are "seated" in their sockets.

Close the electrical-control-panel door.

6.2. Lubrication Procedure

Your power washer was pre-lubricated at the factory. If you install the washer within a six-month period after delivery, no lubrication is necessary before startup.

However, *you must* **establish a lubrication schedule**, based on hours of operation. Refer to chapters *"Advanced Operations: Process-Control"* and *"Maintenance."*

If the washer has been sitting for more than one year after delivery, see chapter *"Maintenance"* later in this manual for information on the proper lubrication procedure before startup.

6.3. Power-up Procedure

> **NOTE**: If you need to stop the power-up procedure at any point, press the *stop button* on the washer's control panel, or *turn off the main power supply*.

Follow this procedure:

Preliminary Checks:

1. Is the cabinet *door closed*?
2. Is the *clock-override switch set OFF*?
3. Is the *wash timer* set to *"0"?*

Supply Voltage:

> ***CAUTION**: This procedure exposes personnel to dangerous voltages and the risk of electrocution. Be sure the people performing this task are qualified and trained for the task.*

1. Verify that the electrical panel door is closed and latched.

2. Turn on the building main power supply to the Power Washer.

3. Turn electrical disconnect located on the MART Washer Control Enclosure door to the “OFF” position.

4. Open electrical enclosure door.

3. Measure and record incoming voltage available to the washer. Perform this test at the *supply side* of the *main disconnect.*

Water-Fill:

1. Set the *temperature controller adjustment to "0."* This will prevent the burner or heating elements from activating when the washer is empty of water, should damage to the washer have occurred in shipping. Refer to chapter *"Advanced Operations: Process-Control"* for more information.

2. Close electrical panel door.

3. Turn the electrical disconnect located on the MART Washer Control Enclosure door to the “ON” position. If the pump/s come on, turn the disconnect “OFF” and **immediately** contact the MART Corp. for additional instructions.

4. Turn the 7-day clock control switch to *Bypass*.

5. Verify by visual inspection or by sound that the washer reservoir begins to fill with water (the water-fill solenoid should open when you turn the main power supply and the clock-override switch ON). Refer to Fig. 2-7 for the water-supply connection location.

6. Set the ASE Timer to 1 minute or any desired time between 0-10 minutes.

7. After about two hours, check the washer reservoir to verify or adjust the set-point water level. (While the reservoir fills, you can continue with the power-up procedure.)

Water-Level Control:

The water-level control system is fully installed in the power washer and requires only verification that the set-point water level is correct for operation of the machine. Follow these steps to verify or adjust the set-point water level:

1. Remove the float control box cover by removing four (4) screws. Refer to the following figure:

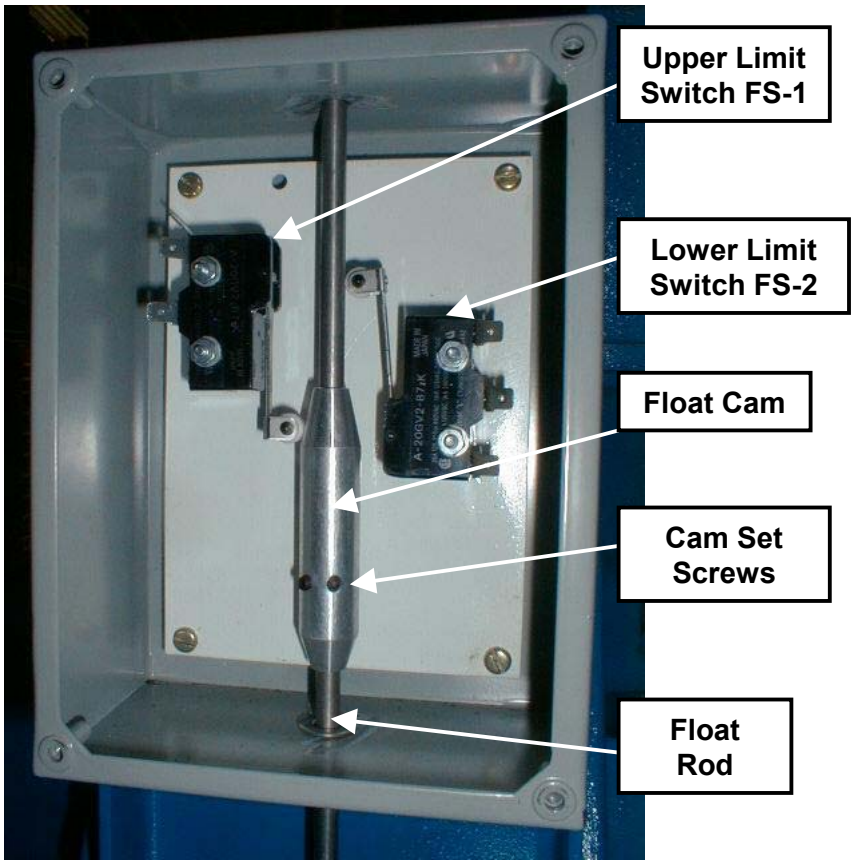


Fig. 2 - 16: Float Control Box

2. During the initial startup of your power washer the washer will fill itself to the set-point water level. This water level is controlled by the position of the cam on the float rod.

   Moving the cam **down** on the float rod will **raise** the water level, while moving the cam **up** on the float rod will **lower** the water level.

   When the washer has completed filling to the set-point water level, the cam and float limit switches should appear as shown in the following figure.

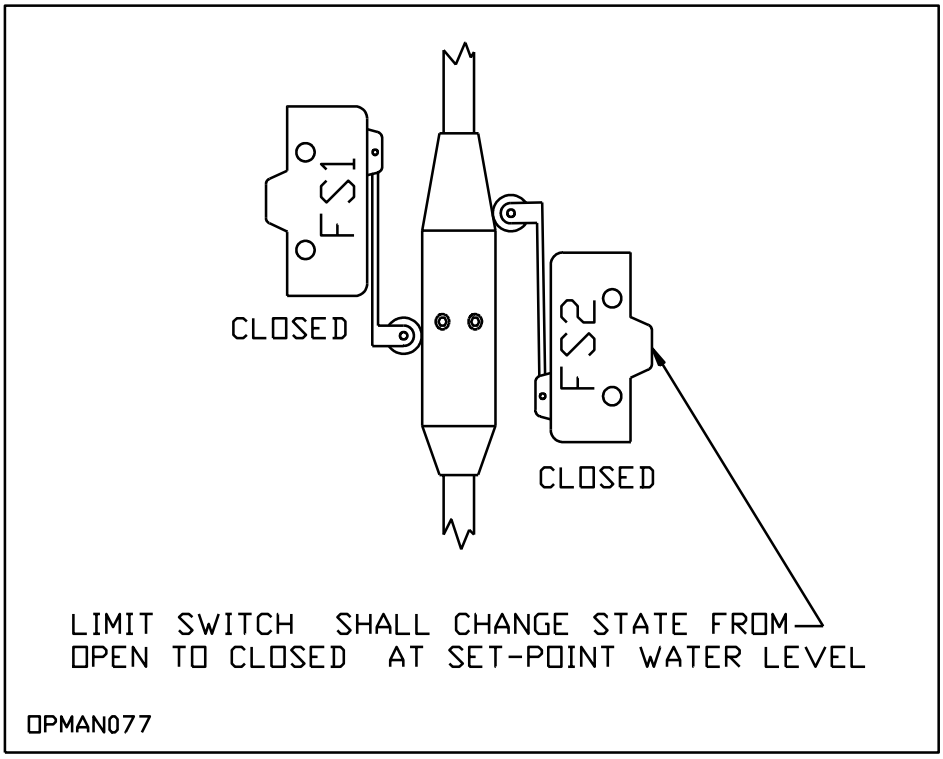


Fig. 2 - 17: Float Cam at SET-POINT Water Level

Turn *OFF* power to the washer.

Make sure the water is calm.

Remove the front reservoir cover.

Verify the water level in the machine when the cam is in relationship to the limit switches as shown in the figure above.

Find the water-level indicator (a 3/8"-square rectangular bar) welded to the right wall at the front of the reservoir. Refer to the following figure.

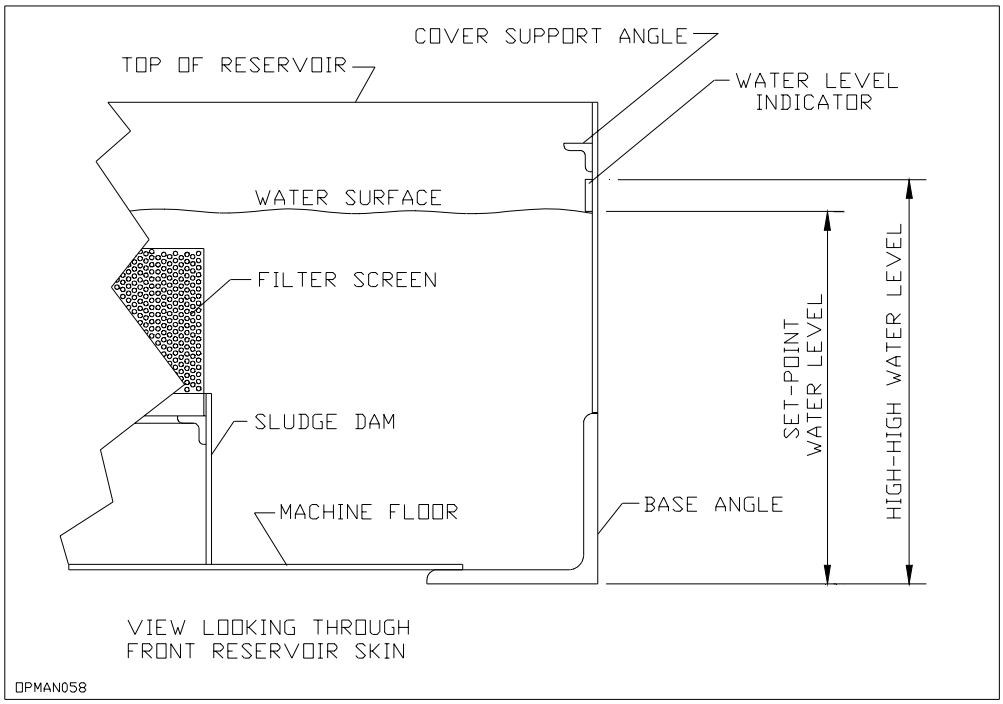


Fig. 2 - 18: Water-Level Set-Point Dimensions and Measurement Location

NOTE: The top of the water-level indicator shows the HIGH HIGH water level. The bottom shows the SET POINT.

3. *If the water level is more than 1/8" inch above or below the bottom of the water-level indicator,* you will need to adjust the cam on the float rod. Follow the steps below.

   -Or-

   If your water level is correct, skip to step 6.

4. Mark the current location of the cam on the float rod with a marker or a piece of tape before making any adjustments.

   If the water-level measurement you made is higher than the indicator, you will need to move the cam **up** the float rod by the difference between the indicator and the measured value

   If the measurement is lower than the indicator, you will need to move the cam **down** the float rod by the difference between the indicator and the measured value.

   Measure the distance to the new position and mark it on the float rod.

   Next, loosen the two set-screws on the cam with an Allen wrench.

   Finally, slide the cam to the new location, and re-tighten **both** set-screws.

5. Turn power on to the washer and test the new level by allowing the washer to fill to the new set point.

   NOTE: It will be necessary to remove water from the washer if the new level is lower than the old set point.

   Verify that the set-point level is correct. If necessary, repeat the above steps until the set-point level is at the indicator, plus or minus 1/8" inch.

6. Replace the cover on the float box and tighten the four screws.

NOTE: If your washer has a rinse system, once operations have started water levels in the washer can be higher than the set-point water level. This happens whenever the washer automatically uses the rinse-bank for longer rinses.

To verify the correct set-point water level after operations have started, you must allow the washer to fill to the set point. You can check this by observing the position of the float cam relative to the limit switches in the float box. (Refer to Fig. 1-3: Float-Level Mechanics) If the cam is higher than the set point, you will have to remove solution from the washer and allow the washer to fill to the set point to check set-point water level.

Control Voltage:

***CAUTION**: This procedure exposes personnel to dangerous voltages and the risk of electrocution. Be sure the people performing this task are qualified and trained for the task.*

1. Measure and record the control voltage to establish a baseline reading by taking readings from *#10 wire on fuse #3* to any *neutral terminal* (on the terminal strip at the top of the electrical control panel). Refer to Fig. 2-9 for terminal-strip location.

2. Verify that voltage readings at each additional #10 terminal are 120 volts, ±10%.

Heat - Gas: (if applicable)

WARNING! IF YOUR POWER WASHER USES A GAS BURNER: If you do not follow installation and operating instructions exactly, a fire or explosion may result, causing loss of life, personal injury, or damage to property.

WARNING! Proper setup and adjustment of gas-combustion equipment requires combustion-analysis tools (gas manometers, gas combustion analyzer) and knowledge of gas combustion.

If you do not have the proper expertise or equipment, seek professional help.

Improper adjustment of gas-combustion equipment can cause carbon monoxide discharge, fire, or explosion, resulting in loss of life, personal injury, or property damage.

1. Measure and record the incoming gas pressure to the burner. (**NOTE**: In the power-up procedure, the burner will not fire until correct water level is reached, and the clock-override switch is turned *ON*.)

2. Verify that the incoming pressure is within the range specified in the table below. Lower gas pressures can reduce the burner firing rate and increase the time it takes for the machine to heat. Gas differential pressures other than those in the table below will cause firing rates other than those obtained at the factory. Use the gas pressures in Fig. 2-18 as an initial starting point for burner adjustments.

3. If your washer has a burner with one of the firing rates listed in Fig-2-18, make initial flue damper and burner air-inlet shutter settings as shown.

NOTE: Gas pressures below are expressed in WCI.

Firing Rate K/BTU	Burner No.	Maximum Incoming Gas Pressure Unfired	Minimum Incoming Gas Pressure Unfired	Incoming Gas Pressure Fired	Minimum Incoming Gas Pressure Fired	Manifold Gas Press Firing	Machine Flue Damper Opening	Burner Air Shutter Opening
80	GT2	12	11	10.5	7.5	n/a	n/a	n/a
180	G2/T6	12	11	10.5	7.5	3.8	30 Deg.	n/a
180	40P200	12	11	10.5	7.5	2.96	30 Deg.	3.25
180	40N200	12	11	10.5	7.5	1.6	30 Deg.	3.25
380	X4-400-9	12	11	10.5	7.5	4-4.7	30 Deg.	8
380	GR 4	12	11	10.5	7.5	4-4.7	30 Deg.	No. 11
780	X4-700-9	12	11	10.5	7.5	3.7-4.8	30 Deg.	8
780	G 6	12	11	10.5	7.5	3.7-4.1	30 Deg.	3/4"

Fig. 2 - 19: Initial Burner Settings

Refer to the startup procedure in the burner vendor's manual.
NOTE: At this point, all manual gas valves should be closed.

4. Verify that the washer reservoir is filled to the factory pre-set level with water. The burner cannot fire until correct water level is reached.

5. Set the temperature controller, according to the following table. After you set the controller, the burner will come on and attempt to fire. (The controller is labeled inside the electrical control panel.) ***NOTE:*** *The set-point on the controller can differ from the actual temperature.*

   At this point you should follow the startup procedure in the burner vendor's manual.

   Note: Due to various installation variables, it may be necessary to adjust operating parameters to obtain consistent burner performance.

Maximum Actual Operating Temperature

Altitude in Feet	*Temperature* ° F
0 - 2000	190° F (88° C)
2000 - 4000	185° F (85° C)
4000 - 5000	180° F (82° C)
5000 and above	call MART

WARNING! Do NOT exceed recommended settings, or serious damage can occur in the wash pump (cavitation).

Fig. 2 - 20: Maximum Operating Temperature

6. Take a sample of flue gases where the flue pipe attaches to the roof of the washer cabinet. There is a port at the flue damper for this measurement.

WARNING! A certified burner technician, using flue-gas-analyzing equipment must make any adjustments to the burner.

7. Verify that the fuel/air mixture is correct, by comparing your readings with the following table. Refer also to your vendor-supplied burner manual.

WARNING! Proper air/fuel mixture is imperative for efficient operation and safety.

Correct Air/Fuel Mixture	
Unburned combustibles	0%
Carbon dioxide (natural gas)	9% -10%
Carbon dioxide (propane gas)	10% -12%
Oxygen	3% to 5%
Combustion efficiency	70% *or more*
Stack temperature	350° F to 1000° F (177° C to 371° C)
Carbon monoxide	200 PPM *or less*

8. Record the water temperature and time of day for reference. Refer to the following figure for gauge location. ***NOTE**: Generally, it takes about two hours for water to heat from 70°* F (21° C) *up to* 190° F (88° C). *While the water is heating, you may continue with the power-up procedure.*

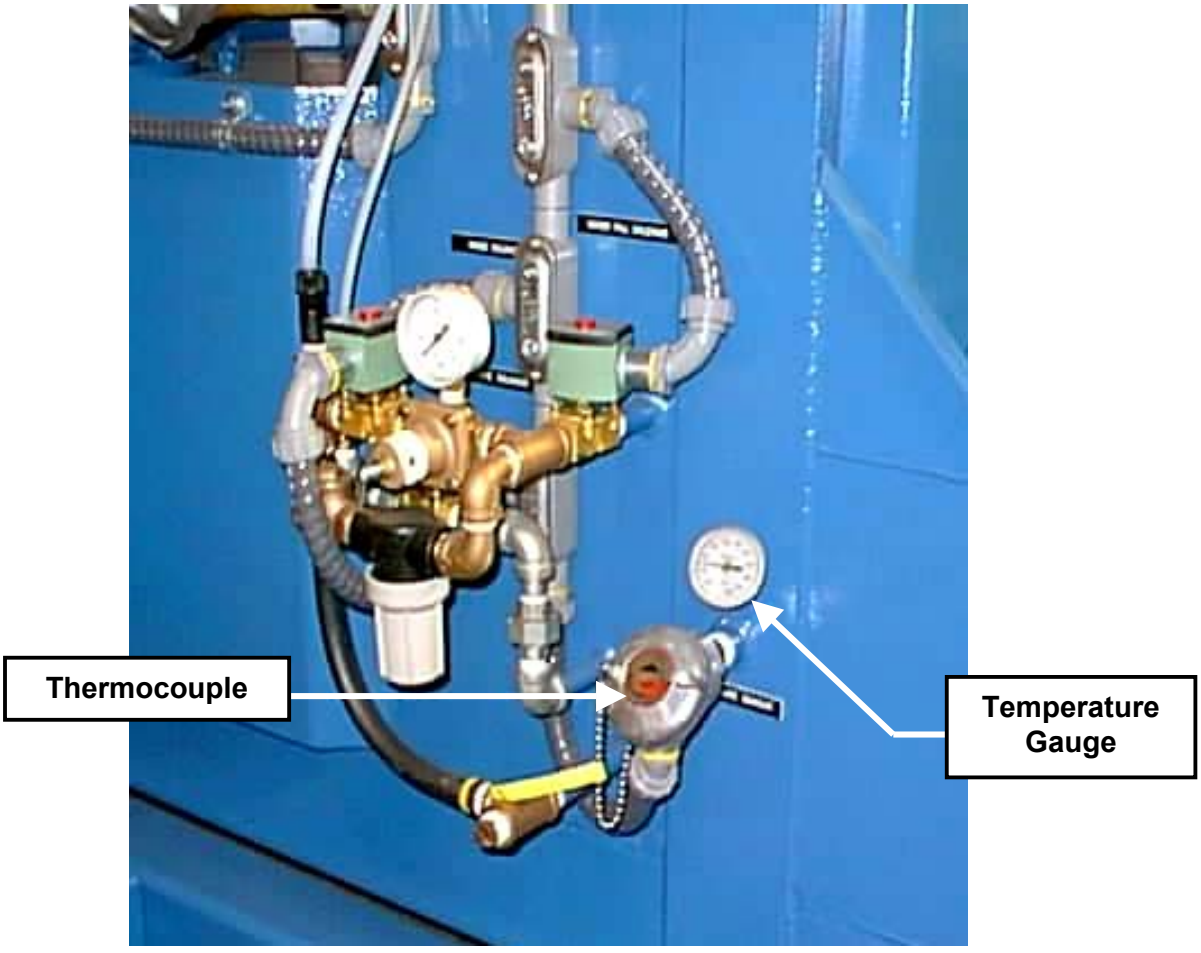


Fig. 2 - 21: Water Temperature Gauge Location

Hi-Limit Controller Adjustment:

MART Power Washers are equipped with a safety control system to prevent over temperature of the gas heating system. A temperature sensor is located in the flue gas stack and connected to a hi-limit controller in the electrical control enclosure. If the flue temperature exceeds the set point on the hi-limit controller, the heating system will shut down.

NOTE: ***MART Power Washers are shipped with the Hi-Limit control set to a predetermined value for your machine size. YOU ARE RESPONSIBLE for accurate adjustment of the Hi-Limit controller. All set-up adjustments are to be done only by people who are qualified and trained for the task.***

NOTE: The Hi-Limit control adjustment should be preformed as an integral part of the burner start-up procedure.

To set-up the Hi-Limit controller, proceed as follows:

1. Adjust the temperature control unit to 220 degrees F.
2. Allow the burner to operate until the water temperature reaches 200 degrees F.
3. Measure and record the exhaust stack temperature.
4. Adjust the Hi-Limit controller 100 degrees F. over the measured exhaust temperature.
5. Reset the temperature control unit to the proper temperature (see Fig. 2 – 19).

The Hi-Limit control is now properly adjusted.

NOTE: ***The set-up and proper adjustment of the HI-LIMIT controller is the responsibility of the end user. Failure to perform the proper set-up will render the hi limit control system inoperative and may violate local codes.***

Heat - Electric: (if applicable)

1. Set the temperature controller. Refer to Fig. 2-20.
2. Check to be sure that the washer is heating.

Heat - Steam: (if applicable)

1. Set the temperature controller. Refer to Fig. 2-20.
2. Check to be sure that the washer is heating.

Heat - Oil: (if applicable)

1. Set the temperature controller. Refer to Fig. 2-20.
2. Follow the instructions in your vendor-supplied oil-burner manual.

Temperature:

1. Verify that the washer continues to heat up properly. Refer to Fig. 2-21 to find the temperature gauge. ***NOTE****: Generally, it takes about two hours for*

water to heat from 70° F (21° C) *up to* 190° F (88° C). *While the water is heating, you may continue with the power-up procedure.*

Pump Rotation Direction:

1. Close and latch the washer cabinet door. (Door to remain closed for balance of this test).

2. Verify proper rotation of the pumps by the following procedure:
   - Set any wash time on the *0-30 minute timer*.
   - Press the s*tart* button.
   - Immediately press the s*top* button.
   - Observe rotation direction of the wash pump shafts. Verify the *clockwise rotation of the pumps*. (**NOTE**: If not correct, have an electrician reverse the direction of the pump by swapping any 2 of the 3 power-supply wires.)
   - Repeat test to verify correct rotation of pump/s.

3. If the pump direction is correct, set the *wash time* for *10 minutes*.

> ***CAUTION****: This procedure exposes personnel to dangerous and hazardous voltages. Be sure the people performing this task are qualified and trained for the task.*

4. Turn the electrical disconnect on the control enclosure door OFF. Open electrical enclosure door. With door open, turn the disconnect ON

5. Press start. Measure and record the incoming voltage to the washer *with wash pump(s) running, and all equipment on the washer operating,* so you have the maximum amperage draw.

> **NOTE:** Take the measurements inside the electrical control panel, at the power distribution block. Refer to Fig. 2-9. If the voltage is more than 10% below the voltage stated on the nameplate of the washer, stop the startup procedure. You must correct the low voltage condition before proceeding with the start-up.

6. With pumps running, measure and record the amp draw from the wash pump motor(s), using a clamp-on amp meter.

> **NOTE**: Take the amperage measurement at the load side of the wash pump starter(s) on each power leg. If the washer is equipped with a duplex pump system, take amp readings separately on each wash pump motor, with both pumps running.

7. Compare amperage readings with the maximum amp load, which is calculated as follows:

On each pump motor, find the manufacturer's specification tag. The tag indicates two things: **(1)** Full-load amperage draw at your specified voltage; and **(2)** The service factor, which is stamped on the motor nameplate

Multiply the full-load draw (as indicated on the motor tag) by the service factor in order to calculate the maximum allowable amp load.

The actual amperage draw reading on each motor is to fall *below* the maximum calculated allowable amp load.

Cycling Test:

Perform the cycling test *after* the reservoir has filled, *and after* the washer has fully heated. **During winter**, "water hammer" may occur more frequently, or be more severe, due to lower ambient temperatures. If these conditions are true, increment the Wash Delay timer settings until "water hammer" stops. Refer to steps #8 and #9 below.

Note: Water hammer is the result of cool air entering a hot enclosure. When the pump system comes on, this cool air is rapidly heated by the hot water solution, which results in a rapid expansion in excess of the normal exhaust system capacity. The excess air pressure generated may cause hot solution to be ejected from the washer.

8. Open washer cabinet door wide open for a minimum of 30 seconds. Close and latch the door.

9. Stand to the side of the washer, and press the *start* button.

10. If water is ejected from under the front reservoir cover:
    - Press the *stop* button.
    - Add additional time to the wash delay timer
    - Repeat steps #8 thru #10 until the water ejection stops.

11. Verify the factory pre-set times for the optional Auto Rinse Cycle (ARC), and the Auto Steam Exhaust (ASE) timers per the following tables.

Timer for:	***Factory Setting:***
Auto Rinse Cycle, (ARC)	1 minute
Auto Steam Exhaust, (ASE)	1 minute

Additional Operational Checks:

11. With machine running a wash cycle, manually depress the float rod down. Verify wash cycle stops immediately. Wash cycle should not be able to be able to be restarted until float rod is released and allowed to return to it's

normal position and the wash door is opened and re-closed.

WARNING! Stand to side of machine for this test.

12. With machine running a wash cycle, CAREFULLY release the door latch handle only enough to allow the door to open slightly (1/4"). Wash cycle should stop immediately. Wash cycle cannot be restarted until door is properly closed and secured.

13. With machine not running a wash cycle, but system heat on, manually depress the float rod down. The heating system should immediately shut off. When rod is allowed to return to its normal position, the heating system should again become functional.

If any of the proceeding operational checks steps 11, 12 and 13 do not function as described, correct the problem before proceeding.

6.4. Chemical-Charging Procedure

If you have successfully completed the startup procedure to this point, you are ready to charge the washer with chemical.

When you charge the washer with chemical, always follow the chemical manufacturer's recommendations.

In general, most manufacturers recommend 4-6 oz. (120ml - 180ml) of chemical per gallon of water.

WARNING! When handling chemicals, always wear gauntlet-type thermally protected and water-repellent protective gloves, protective eyewear, a filter-type air mask, and a full body apron that is thermally protected and water-repellent. Use a long-handled shovel only, when working with or dispensing granular chemical. (Some chemical is liquid.)

*For **granular chemical,** follow this procedure*:

1. Open and secure Power Washer door.

2. Using a Long-handled shovel and wearing protective gear and clothing, slowly place chemical on the false floor in the rear of the MART Power Washer. Do not dump chemical directly into washer reservoir. Violent exothermic (heat released) reactions, splashing of chemically and physically

heated solutions and the premature release of fumes may occur. Avoid contact with chemical and solution. Avoid inhaling dust and fumes.

3. Close the washer door and start the pump to dissolve the detergent. Operate the wash cycle @ 160 to 190 degrees F.

*For **liquid chemical,** follow this procedure*:

1. Turn the ***main power supply OFF***.

2. Pump out the amount of water that is to be replaced by liquid chemical.

3. Pump the liquid chemical ***SLOWLY*** from drums onto the false floor, *or* over the doorframe.

> ***CAUTION! Use extreme caution when pumping liquid chemical! The operator should stand back from the washer and wear gauntlet-type thermally protected and water-repellent protective gloves, protective eyewear, a filter-type air mask, and a full body apron that is thermally protected and water-repellent.***

> ***WARNING! Do NOT pour liquid chemical into the front reservoir.***

4. Turn the *main power supply ON*.

6.5. 7-Day Dual-Circuit Clock Initialization

After you have completed the chemical-charging procedure, initialize the 7-day dual-circuit clock.

Follow these instructions:

1. Set the 7-day clock. Refer to the vendor-provided manual for details. Also refer to section *"Setting the 7-Day Dual-Circuit Clock"* in chapter *"Advanced Operations: Process-Control"* in this manual.

2. Re-set the clock-override switch, located on the control panel, from the *on* position to the *off* position: this allows the 7-day clock to automatically operate the heating circuit.

3. To perform a test wash of actual parts, see chapter *"Basic Operations."*

6.6. Rinse System (optional)

This option arrives factory-installed. All you have to do is open a chemical barrel, place the strainer tube in the bottom of the barrel, and prime the injector pump.

To prime the injector pump, *follow these guidelines*:

1. Shut off the incoming water supply.

2. Turn off the main-power-supply disconnect switch, located on the outside of the door of the electrical control panel and open the door.

3. Set the rinse timer to the maximum rinse time. (The rinse timer is located inside the electrical control panel.)

4. Close the door of the electrical control panel.

5. Turn on the main-power-supply disconnect switch.

6. Put the washer in to the rinse cycle.

   To do this, press *start*, then turn the wash timer to *0*.

   (When the washer begins a rinse cycle, the injector pump turns on.)

7. Turn injector-pump speed to *10*, until solution enters injector discharge.

   CAUTION! Do not adjust injector-pump speed unless you have already put the washer in to the rinse cycle! Adjust injector-pump speed control ONLY while the injector pump is running.

   The injector pump is now primed.

8. Press *stop*.

9. Turn off the main-power-supply disconnect switch, located on the outside of the door of the electrical control panel.

10. To set the rinse timer and injector-pump speed control, refer to chapter *“Advanced Operations: Process-Control.”*

6.7. Startup Problems

If you have any problems during the startup procedure, do the following:

- Re-read this chapter (*"Installation"*)
- Refer to chapter *"Troubleshooting"*
- Call MART

After you have completed startup with no problems, you are ready to run a wash cycle. Refer to chapter *“Basic Operations.”*

3 Basic Operations

Purpose

This chapter provides step-by-step instructions on how to load and wash parts. Read it before you operate the washer for the first time.

Prerequisites

Before you read this chapter or operate the washer for the first time, we recommend that you read the following thoroughly:

- *"Important Safety Instructions and Warnings"* (in the front material)
- Chapter 1, *"Overview"*

> This chapter, *"Basic Operations,"* assumes that appropriate operating parameters have been established for your washer. Refer to chapter *"Advanced Operations: Process-Control"* for information on establishing process-control parameters.

Safety/Precautions

Before you operate the washer, read and follow these recommended safety/precaution instructions:

> ***WARNING! NEVER get inside the washer cabinet when the main power supply is ON. This could result in severe injury or death.***

CAUTION! <u>WHEN LOADING AND UNLOADING PARTS</u>! -- Always wear gauntlet-type thermally protected and water-repellent protective gloves, protective eyewear, a filter-type air mask, and a full body apron that is thermally protected and water-repellent.

CAUTION! <u>WHEN LOADING AND UNLOADING PARTS</u>! -- After a cleaning cycle, parts are very hot. Trace amounts of chemical residue remain on part surfaces and in recesses. <u>Before</u> you remove a part from the washer cabinet, be sure to <u>drain back into the washer</u> any solution that remains on a part surface or in recesses.

What You Will Learn In This Chapter

In this chapter you will learn the following about operating the washer:

- Control panel
- Standard cleaning cycle
    - Checking water temperature
    - Using the clock-override switch
    - Opening the Door
    - Loading and Securing Parts
    - Closing and locking the Door
    - Verifying Wash Temperature
    - Setting the Timer
    - Setting the Rinse Cycle (optional)
    - Starting the Washer
    - Verifying Proper Function
    - Opening the Door after a Cycle
    - Unloading Parts
- Continuous operation

1. Control Panel

The following figure shows the standard control panel, located on the outside of the washer cabinet to the left of the door. The operator uses these controls in day-to-day cleaning-cycle operations:

Hour Meter	Monitor the total number of hours of washer cycle time for scheduled maintenance procedures, from *start* to the *end* of cycle.
Rinse off/auto	set the rinse switch to *AUTO* to enable the rinse cycle; OFF bypasses the rinse cycle.
7-Day Dual-Circuit Clock	Program heat-up days and start/stop times for heat and water-fill; program circuit #2 to control the "auto" runtime for the optional Clean Machine or Oil Skimmer.
Wash Cycle Timer	Set 0-30 minute wash cycle
7 Day Clock	Select *BYPASS* to override the 7-day clock. Select *ON* to enable the 7-day clock control.
Turntable Jog	Press the *TURNTABLE JOG* button to rotate the turntable for easier loading/unloading.
Start (Run Light)	Press the *START* button all the way to begin the wash cycle. The green run light illuminates indicating cycle running. **Note**…The start circuit is interlocked with the door closed limit switch. The opening and closing of the washer door resets the start circuit.
Stop/*Reset*	Press the *STOP* button to stop washer operations (heat source and water-fill functions are not affected). The green “Run Light” extinguishes indicating cycle terminated.

NOTE: If you have purchased any options, such as the Clean Machine, Oil Skimmer, or Conductivity Controller, their operator controls will appear on the control panel, if applicable. Refer to chapter *"Options"* for more information.

NOTE: If you specified any custom features, your control panel may differ slightly from the standard panel. For example, your wash timer may be located inside the electrical control panel. If you requested a *water fault indicator*, it illuminates only if the water level falls below operational requirements.

For more information on installing, operating, and maintaining options, refer to chapter *"Options."*

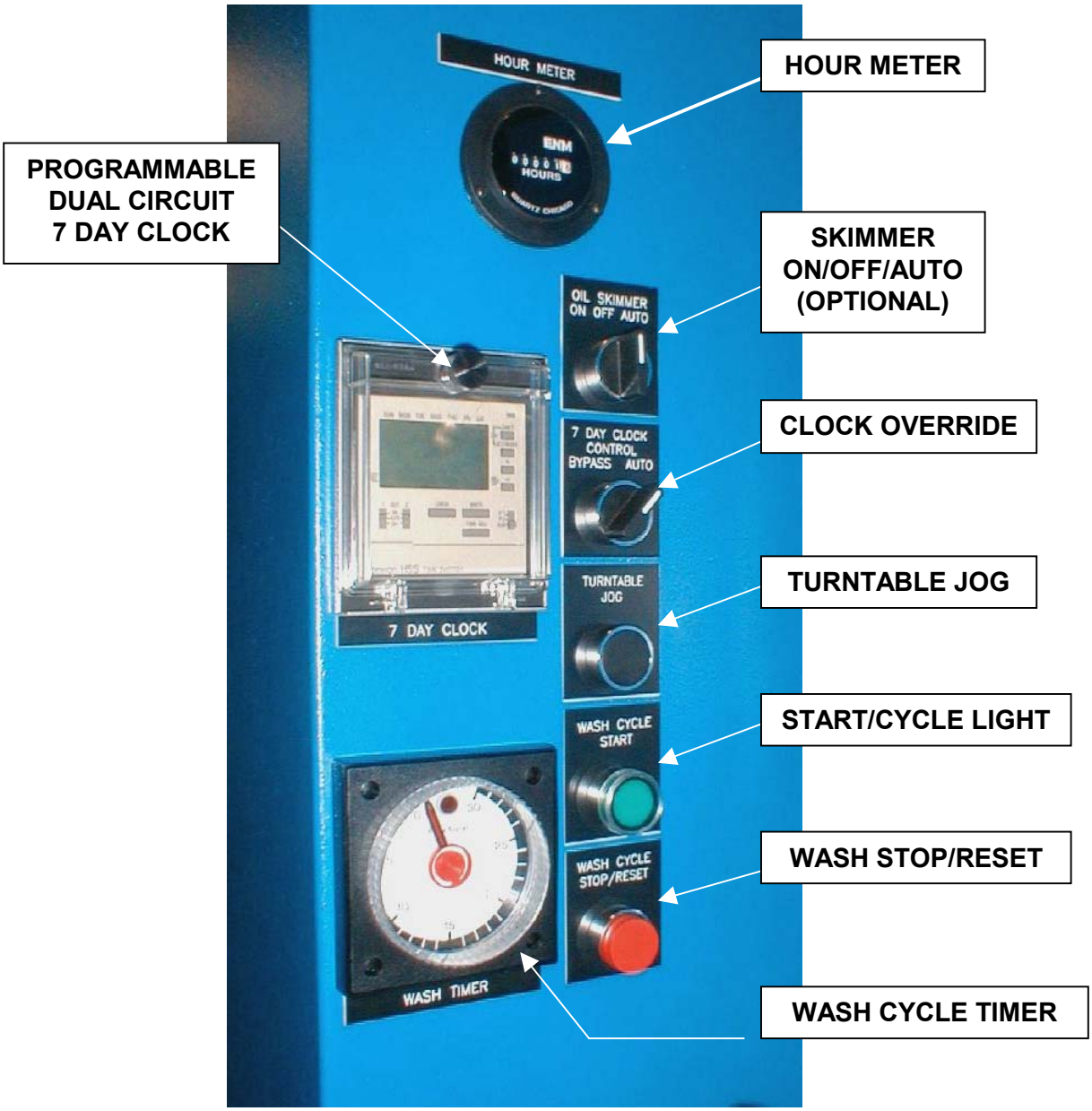


FIG. 3-1: Standard Turntable Power Washer Control Panel

2. Standard Cleaning Cycle

This section explains how to operate the washer. Read it before you run a cleaning cycle for the first time.

2.1. Checking Water Temperature

Check the water temperature gauge to verify that the washer has reached the *minimum operating temperature* specified by your process-control instructions. Refer to the following figure for the gauge's location.

> ***WARNING! Do NOT operate the washer unless it has reached minimum operating temperature.***

Scheduled Shift: During a scheduled shift, check the temperature gauge about every 15 minutes until it reaches the specified operating temperature. If the gauge shows no change after 30 minutes or so ***and*** the washer has not reached the specified operating temperature, refer to chapter *"Troubleshooting."*

Non-scheduled Shift: To run a wash cycle during a non-scheduled shift, use the *clock-override switch* to bypass the 7-day clock. Refer to the next section.

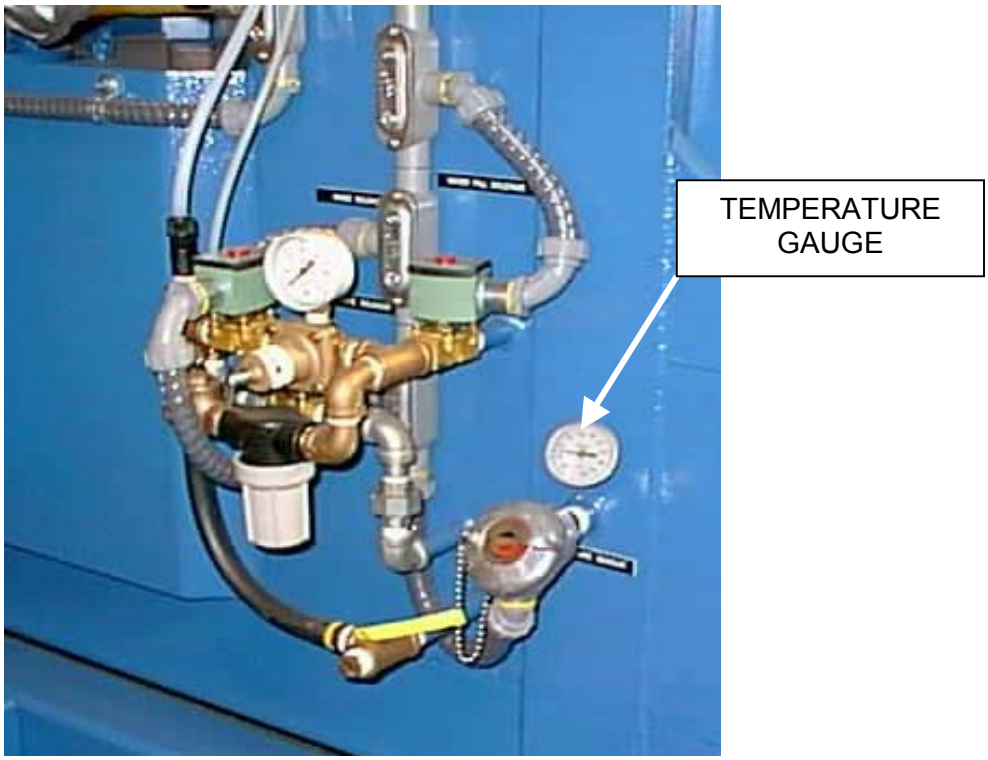


Fig. 3 - 2: Water Temperature Gauge Location

NOTE.

The water temperature gauge monitors and displays the wash solution temperature (at a specific location) in the wash tank. During the start of a cleaning cycle, wash solution temperature will decrease for the following reasons:

- A cold washer cabinet (first wash of the day or extended idle time between washes).
- Cold air in washer cabinet (door left open for extended time).
- Washing action on cold parts (cooling of returning water).
- Stratification of hot and cold water during extended idle times.
- Excess steam extraction (ASE system extracting excessive steam and heat).

This fluctuation from temperature setpoint (highest desired solution temperature as set on the internal temperature control unit) is to be considered normal operation of the system.

To increase the “average” wash temperature, increase the set point temperature on the control unit inside of the electrical control enclosure. This will increase the “starting” wash solution temperature.

2.2. Using the Clock-Override Switch

Use the clock-override switch to bypass the 7-day clock and heat the washer. Refer to Fig. 3-1. Generally, you would use this switch under the following conditions:

- You are ***not*** on a scheduled production shift
- ***And*** you need to run a wash cycle
- ***And*** the gauge shows the washer is not at operating temperature

Check the temperature gauge about every 15 minutes until it reaches the specified operating temperature. If the gauge shows no change after 30 minutes or so ***and*** has not reached the specified operating temperature, refer to chapter *"Troubleshooting."*

Allow approximately 1-2 hours for the washer to reach operating temperature from an “ambient” condition.

2.3. Opening the Door

Door Latch

Pull the latch *handle* away from the washer cabinet to release the latch. Refer to the following figure.

Swing the latch *hook* away from the door handle.

Pull the door open *slowly*.

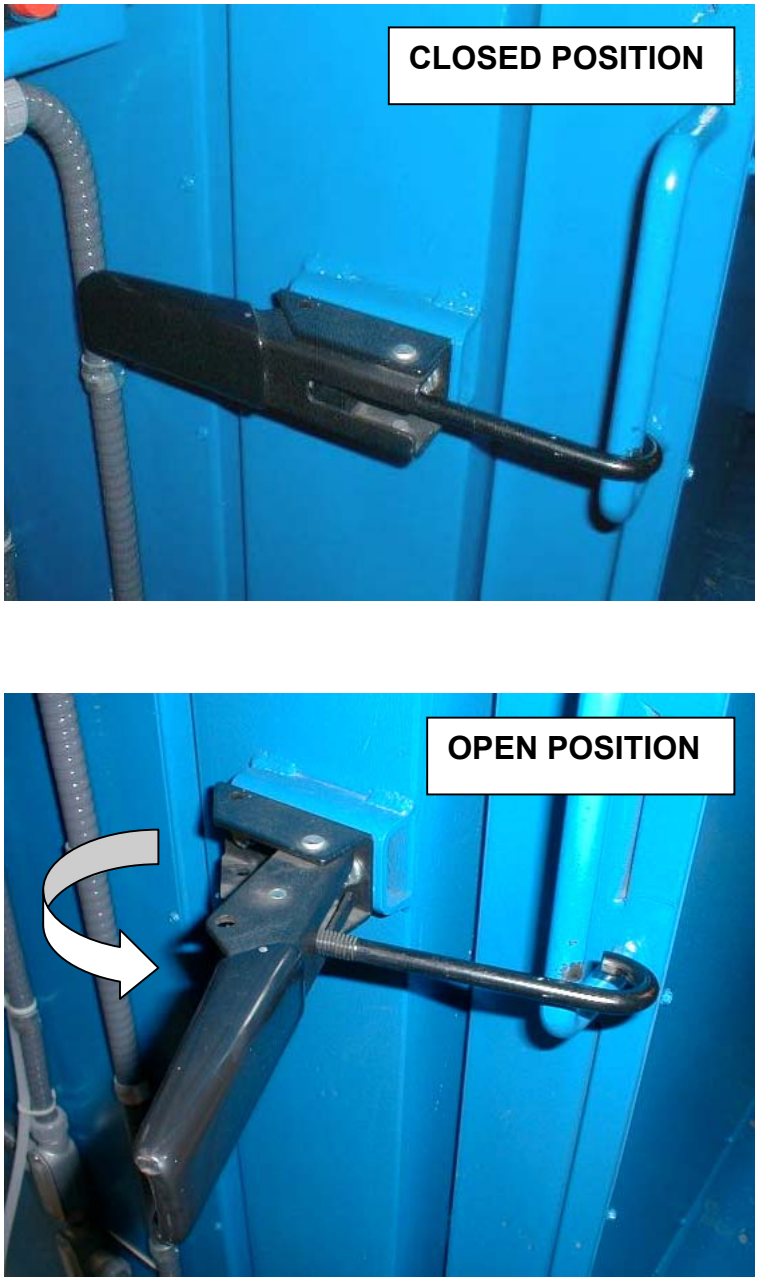


Fig. 3 - 3: Cabinet Door Latch

Position Lock

Pull the door open *slowly*, until it locks in the *first* position.

To lock the door in the *second* position:

1. *Rotate the position-lock handle upward to release the* lock from the first position.
2. Move the *door* back *slowly*.
3. Release the *position lock*.
4. Continue pushing the *door* until it locks in place.

The position-lock handle is located at the bottom of the door. The two position locks hold the door open at approximately 60° angle and 90° angle, respectively, from the front of the cabinet. Refer to the following figure.

Securing the Door

Always be sure that the open door is locked in position:

- Visually check the position lock, *or*
- Try to pull or push the door

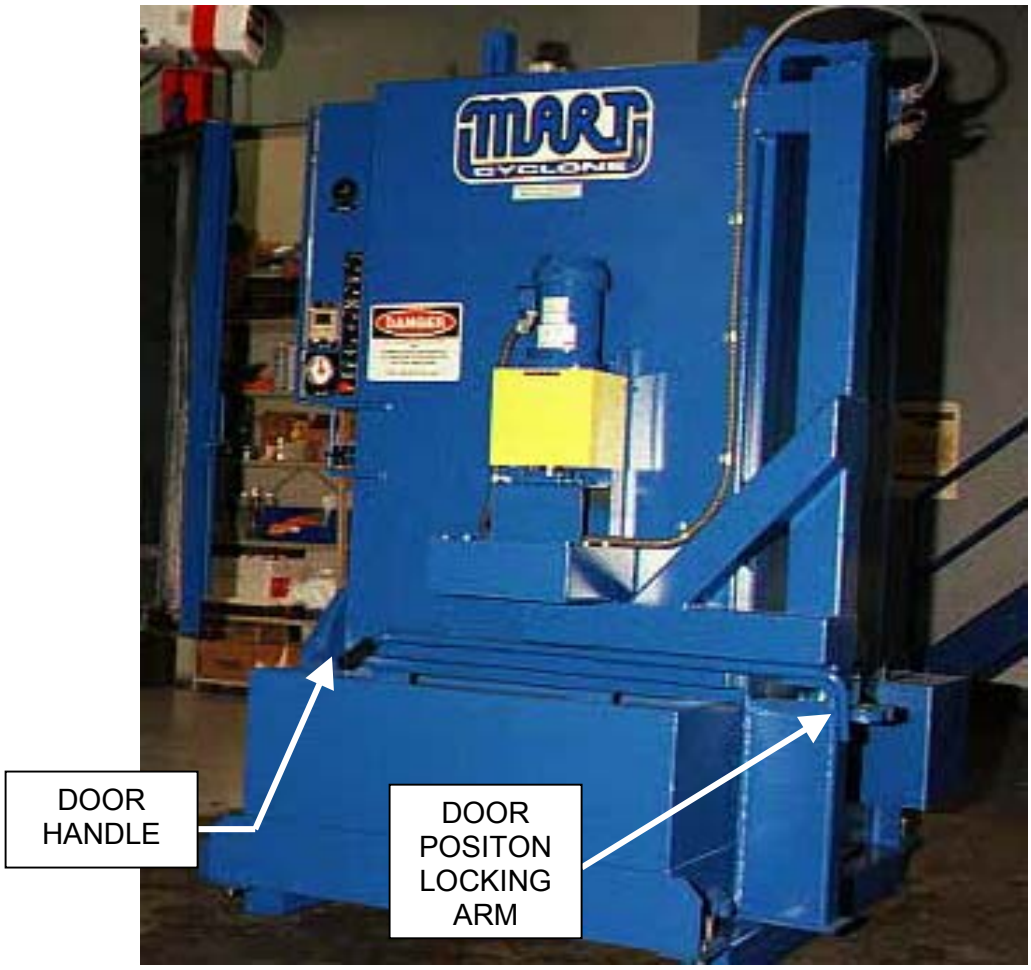


Fig. 3 - 4: Cabinet Door Position Lock

2.4. Loading and Securing Parts

Place all parts as near to the center of the turntable as possible. Position parts vertically whenever possible in order to take greatest advantage of the PBM's blasting system.

> ***WARNING! All parts must fit within the diameter of the turntable. The load should be centered on the turntable and must not extend beyond the edge of the turntable.***

Securing Devices

All parts, small or large must be loaded at the center of the turntable and secured to the turntable. The type, size, and weight of the part determine whether you would use, for example, chains or nylon tie-downs. Remember that the washer blasts parts with a lot of power, especially models with larger pumping systems.

> ***NOTE!*** **Turntable load ratings are for parts loaded *exactly* at the *center* of the turntable.**

Guideline: Assume that every nozzle hits every part with 15 lbs. (6.8 kg) of force.

Recommendations:

- Wrap securing devices *tightly* around all fixtures and parts.
- Loop securing devices through eyelets, stems, hooks, and handles on fixtures.
- Wrap securing devices around the outer perimeter of the part load at least once, and through any part openings, ports, etc., if possible.
- Wrap the ends of each securing device into appropriate slots, handles, etc., on fixtures, or attach to hooks on the turntable, so they don't catch on the turntable sprocket drive.
- Be sure that all securing devices clear the lower manifold nozzles and the turntable support arms, if the devices extend below the bottom of the turntable.

Fixtures

Smaller parts can be placed into *baskets*. Fasten larger parts to the turntable using *fixtures.*

The turntable contains *adapter holes* for securing fixtures.

If you have purchased optional "quick change" fixtures from MART, refer to chapter *"Options"* for more information on using them.

2.5. Closing and Locking the Door

> ***CAUTION! Close the door slowly! Be especially careful if the floor is wet or slippery!***

Position Lock

To close the door, rotate the *position-lock handle upward* to release the lock from the first or second position. Then, hold the handle up and push the door *slowly* toward the cabinet, until it shuts.

The position-lock handle is located at the bottom of the door. Refer to Fig. 3-4.

Door Latch

Swing the latch *hook* toward the door handle.

Push the latch *handle* toward the washer cabinet to close and lock the latch. Refer to Fig. 3-3.

2.6. Verifying Wash Temperature

Check the water temperature gauge again to verify that the washer has reached the *minimum operating temperature* specified by your process-control instructions *before* setting the timer. Refer to Fig. 3-2 for the gauge's location.

If the gauge still has not reached the specified operating temperature, refer to chapter *"Troubleshooting."*

> ***WARNING! Do NOT operate the washer unless it has reached minimum operating temperature. Excessive foaming and additional water loss may occur.***

2.7. Setting the Wash-Cycle Timer

Rotate the 0-30 minute wash-cycle timer knob *counterclockwise* to desired time to set wash-cycle time. Refer to Fig. 3-1. During a wash cycle, the black pointer on the timer will remain at set point. The red cycle-progress pointer will move to indicate time remaining. At the end of a wash cycle, the red pointer will reset to the time indicated by the black pointer. This feature allows you to repeat the same cycle time by just pressing *start*.

> ***NOTE!*** **The red pilot light on the timer is *on* during the wash portion of a cleaning cycle.**

Actual Wash Time Set the timer to your shop's normal operating standards. If none exist, you will have to develop them. Only experimentation will give you optimal wash time.

NOTE: In general, most cleaning cycles can be completed in less than 15 minutes.

2.8. Setting the Rinse Cycle (optional)

If you have the optional Automatic Rinse Cycle (ARC), setting the *rinse off/auto switch* to the *auto* position will *enable* the rinse cycle. Setting the switch to *off* will *bypass* the cycle; no rinse will occur. Refer to Fig. 3-1.

2.9. Starting the Washer

Press the *start* button to begin the wash cycle. Refer to Fig. 3-1. The button will remain illuminated during the cycle.

Shifting Load: If the load on the turntable is not centered on the turntable and secured to the turntable, it will shift (noisily) as soon as the main wash pump starts. The turntable-drive-motor jackshaft may also stop rotating. If this occurs:

1. Press the *STOP* button. Wait at least 10 seconds for the pumps to stop running. (Refer to Fig. 3-1.)
2. Verify that the *start* button light is off.
3. Open the door *slowly* (parts could fall out on you).

> ***CAUTION! Open the door slowly! Stand back to avoid any traces of steam! Stand back to avoid falling parts!***

4. Center the parts on the turntable.
5. Secure the parts.
6. Close and lock the door.
7. Press the *START* button again.

NOTE: To stop the cleaning cycle at any time, press the *STOP* button. To restart the washer the start circuit must be reset by opening and reclosing the washer door.

2.10. Verifying Proper Function

Normal Cycle

During the cleaning cycle, verify proper function in the following ways:

- Listen to the pump -- does it sound normal?
- Is the turntable drive-motor jackshaft rotating?

Cycle Completion

At the end of the cleaning cycle, the following things should happen:

- *START* button light turns off
- Turntable drive-motor and ASE blower turns off.
- Wash timer red pointer resets to set point wash time.

2.11. Opening the Door after a Cycle

Wait for the lighted *start* button to turn off before you open the door after a cleaning cycle.

CAUTION! Open the door slowly! Stand back to avoid any traces of steam! Stand back to avoid falling parts!

Door Latch

Pull the latch *handle* away from the washer cabinet to release the latch. Refer to Fig. 3-3.

Swing the latch *hook* away from the door handle.

Pull the door open ***slowly.***

Position Lock Pull the door open *slowly*, until it locks in the *first* position. Do *not* open the door past the first position lock: this allows remaining solution to drip into the reservoir, not onto the floor.

The position-lock handle is located at the bottom of the door. Refer to Fig. 3-4.

Securing the Door Always be sure that the open door is locked in position:

- Visually check the position lock

- Or-

- Try to pull or push the door

2.12. Unloading Parts

Press the *TURNTABLE JOG* button to rotate and position the table for easier unloading. Refer to Fig. 3-1.

Remove the cleaned parts.

3. Continuous Operation

To operate the washer continuously, repeat *"2.4. Loading and Securing Parts"* through *"2.12. Unloading Parts."*

You may need to add chemical or perform maintenance. Refer to chapters *"Advanced Operations: Process-Control"* and *"Maintenance"* in this manual.

4 Advanced Operations: Process-Control

Purpose

This chapter explains how to establish operating parameters to optimize the performance of your MART Power Washer. Use information about the following to help get the best cleaning results and optimize energy usage, while minimizing chemical usage and problems:

- Managing chemical concentration
- Setting rinse cycle time (optional ARC)
- Setting the 7-day dual-circuit clock
- Monitoring assemblies and parts

Prerequisites

Before you read this chapter, we recommend that you read the following thoroughly:

- *"Important Safety Instructions and Warnings"* (in the front material)
- Chapter 1, *"Overview"*
- Chapter 3, *"Basic Operations"*

Safety/Precautions

Before you operate the washer, read and follow these recommended safety/precaution instructions:

> ***WARNING! <u>Never</u> get inside the washer cabinet when the main power supply is ON. This could result in severe injury or death.***

What You Will Learn In This Chapter

In this chapter you will learn the following about establishing operating parameters:

- Chemical-concentration management
- Temperature adjustment
- Rinse-system control (optional ARC)
- Setting the 7-day clock
- Steam-exhaust timer
- Monitoring

1. Chemical-Concentration Management

This section discusses the following topics:

- Chemical: General
- Selecting the right chemical
- Selecting the right concentration
- Maintaining the proper chemical charge
- Problems
    - Foaming related to chemical concentration
    - Supersaturation of solution
- Charging the power washer with chemical

1.1. Chemical: General

Your MART Power Washer uses an aqueous (water-based) alkaline cleaner, not a solvent. When charged with a *light* concentration of cleaner, the washer will give you excellent cleaning results. Generally, *light* means a 2-5% concentration by volume of any high quality non-foaming chemical compound.

Good chemical management should be done on a daily basis. Check the concentration of the cleaning solution and adjust it as necessary -- this is important not only for cleaning results, but it will also reduce cleaning time and other chemical-related problems such as foaming.

You must also use some chemical during the cleaning cycle in order to prevent corrosion (rusting) damage to the washer itself.

Most chemicals provide adequate corrosion prevention at low concentrations, but some do not. Generally, to prevent corrosion the pH of the solution must be above 10.5. Your MART Service Tech. can discuss with you in more detail the pH requirements, and which chemicals may cause corrosion. If you do not know what your solution pH is, you must monitor it to verify that it is kept above 10.5.

MART Power Washers are aqueous based cleaning systems. They are designed and manufactured to work with wash solutions that are of the same specific gravity and viscosity as water. Chemicals or additives, which alter the specific gravity or viscosity of the wash solution, will change the overall performance of the system. Use only chemicals that are designed for use in aqueous systems.

1.2. Selecting the Right Chemical

When you select a chemical, *first* determine the compound best suited for the type of metal or part. *Second*, take into account the type of soils to be removed.

Use the following guidelines in selecting the right chemical:

Type of Metal

for **ferrous metals**, such as cast iron or steel, select a caustic compound containing sodium hydroxide or potassium hydroxide.

For **non-ferrous metals**, such as aluminum, select compounds specifically designed to wash parts without destroying them. Such compounds contain, for example, sodium metasilicate, trisodium phosphate, and sodium bicarbonate. The compound may also contain a small percentage of inhibited caustic, to make it more aggressive, without damaging the metals.

WARNING! Exposing aluminum to a high concentration of caustic chemical, such as sodium hydroxide or potassium hydroxide, will blacken the surface of the parts being cleaned, and, if exposed for five minutes or more, can etch the surface.

Type of Soils

A wide of range of compounds is available to remove soils. Each compound reacts differently with the soils -- some are more aggressive than others at "popping" certain soils from part surfaces. However, no compound removes all types of soils equally well.

To select a chemical, decide which soils you most want removed.

For further details on various chemical compounds and their suitability for your application, call your MART Service Tech to discuss your requirements, or contact your chemical supplier.

WARNING! The selected chemical must prevent corrosion to the steel parts in your washer. Generally, a solution pH above 10.5 is required. Do not use chemicals that cause corrosion, or that cause a solution pH below 10.5.

WARNING! The selected chemical must be <u>non-foaming</u>.

1.3. Selecting the Right Concentration

The MART Power Washer is a high-pressure, high-temperature cleaning system that uses a balance of the following factors to achieve cleaning results:

Power x Temperature x Chemical x Time = Clean

Because the *exact* combination of these factors depends on your shop's cleaning standards and operating requirements, specific chemical concentration recommendations are not possible. Below are formulas for calculating the amount of chemical needed to charge a reservoir of water for cleaning. To use these you will need to know the volume of your washer's reservoir and the recommended initial chemical concentration. Select the formula to use based on whether your chemical is powder or liquid.

For Powder:

Reservoir Size (gal) x Recommended Concentration (oz/gal) = lbs. of Chemical to add.
Divided by 16 oz. / lb.

For Liquid:

Reservoir Size (gal) x Recommended Concentration (oz/gal) = gals. of Chemical to add.
Divided by 128 fluid ozs. / Gal

You must test and adjust the variables in your application to determine an effective chemical type and concentration.

Chemical concentration depends on:

- Your cleaning standards
- Type of metal or material being cleaned
- Shape of parts
- Type of soils to be removed
- Rate of speed required in cleaning
- Operating temperature of the washer
- Water hardness

Every chemical compound has an optimal operating temperature range. Generally, chemical is more aggressive at higher temperatures. As a general rule, for every 10° F (6° C) rise in temperature, a chemical reaction doubles in speed.

The MART Chemcial Group offers a complete range of chemcials for use in MART Power Washers. They can help you select the proper chemical from our Power Kleen line and recommend an appropriate initial chemcial concentration.

If you are using you own chemcials contact your chemical supplier for details -- and adjust your MART Power Washer's chemical concentration accordingly.

1.4. Maintaining the Proper Chemical Charge

After you have developed an effective chemical concentration, as described in the previous section, you must monitor and maintain it for optimal cleaning results and washer performance.

Initially, you could start by monitoring chemical concentration weekly (or, every 40 hours of washer operation). However, you should develop a monitoring schedule based on the frequency of washer operation, degree of cleanliness required, the types of soils to be removed from parts, and so on. Your monitoring schedule should account for all the variables in your application in order to give you the best cleaning results, while using the least amount of chemical possible.

For help in developing a chemical-concentration-monitoring schedule, call your MART representative to discuss your application(s) and requirements, or contact your chemical supplier.

There are two fast and accurate monitoring methods:

1. **Titration Test**

   Perform this test to determine the concentration of chemical by titrating the alkalinity of the solution with an indicator and a drop count.

   The results determine the number of ounces of chemical to add per gallon of water-capacity.

   Refer to chapter *"Maintenance"* for procedural information.

2. **Conductivity Test**

   Conductivity testing equipment is optionally available from MART. Refer to chapter *"Options"* if you have purchased a conductivity controller and probe equipment for your washer.

1.5. Problems

There are two principal problems related to managing chemical concentration:

- Foaming
- Supersaturation of solution

For related information, refer to chapters *"Maintenance"* and *"Troubleshooting."*

1.5.1. Foaming Related to Chemical Concentration

Foaming can occur for these reasons:

- Chemical compound
- Type of soils being removed
- Improper solution temperature

Chemical

the de-foaming component in a chemical compound represents only a small percentage of the total compound. And, de-foaming component percentages vary from compound to compound. Since the washer requires only a light chemical charge, you may need to add a *"booster charge" of de-foamer*, if foaming is a problem.

Consider adding a defoaming agent rather than more chemical, given the following conditions:

- Your cleaning needs are being met.
- You have determined that the type and amount of chemical are appropriate for the soils being removed.
- You have determined that the washer's operating temperature is appropriate for the type of soils, and the type and amount of chemical.

Soils

The type(s) of soils can react adversely with the chemical during cleaning to cause a foaming problem. Select a chemical that is appropriate for the soils to be removed. It is also a good idea to check with your MART representative or your chemical supplier to be sure that the type and amount of chemical are appropriate for the following:

- Type of metal
- Makeup of part(s)
- Operating temperature of the washer

Temperature Test and adjust the washer's operating temperature to determine what is optimal for your chemical. Remember that altitude, water hardness, and types of soils can also affect the temperature-and-chemical reaction. Refer to section *"Temperature Adjustment"* in this chapter.

If you need to discuss your application(s) and requirements, call your MART representative or contact your chemical supplier.

1.5.2. Supersaturation of Solution

The MART Power Washer is a closed-loop cleaning system. It re-uses the cleaning solution without discharging it for treatment or disposal.

When the cleaning solution is fully saturated with greases and oils, merely adding more chemical will not improve cleaning results -- the volume of emulsified greases and oils is greater than the grease to be removed and has no where to go. This condition is called *supersaturation of solution*.

To correct this problem, you must remove *greases and oils* from the solution. Allow solution to cool and oils to rise to surface, then:

- Manually skim greases and oils from the front reservoir; change the solution.

- Or -

- Run the optional **Oil Skimmer** device. If you have purchased one from MART, refer to chapter *"Options"* in this manual.

As part of the sludge clean-out procedure, you will clean out/re-charge the power washer with chemical. Refer to chapter *"Maintenance"* for the sludge clean-out procedure.

1.6. Charging the Power Washer with Chemical

Refer to chapter *"Installation,"* section *"Startup Procedure, Chemical-Charging"* for instructions.

1.7 Corrosion Protection

Since alkaline cleaners are non-corrosive to ferrous metals the cost to manufacture cleaning equipment can be reduced. Stainless steel is not required for construction and protection of the reservoirs, pumps, tanks, cabinets and turntables. In fact carbon steel can be used for the reservoirs and cabinets with no detrimental effects as long as the concentration of alkalinity is maintained. With proper mantainance of your chemcial

concentration the carbon steel components are well protected and will provide years of service. Carbon steel MART power Washers are still in service that are 20+ years old.

Many chemicals provide adequate corrosion prevention at low concentrations, but some do not. Generally, to prevent corrosion in carbon steel the pH of the solution must be above 10.5.

MART Power Washers are aqueous based cleaning systems. They are designed and manufactured to work with wash solutions that have the same the specific gravity and viscosity as water. Chemicals or additives, which alter the specific gravity or viscosity of the wash solution, will change the overall performance of the system. Use only MART Power Kleen chemicals or other chemicals that are designed for use in aqueous systems.

Below is a short introduction to the complete chemical line offered by the MART Corporation Chemical Group.

1.8 MART Chemical Group

MART Power Kleen detergents and additives are specially formulated for use in all MART Power Washers. Power Kleen products cover a wide range of applications and most likely there is a Power Kleen product specifically designed for your particular cleaning applications. In all cases Power Kleen products provide the highest degree of efficient, effective cleaning.

Power Kleen products are highly effective at controlling foaming and are labeled "Controlled Foam" products. Additional defoamer products are available to help in difficult foaming situations.

Power Kleen products remain effective longer than many other detergents used in cabinet washer applications and, in many instances, less Power Kleen detergent is required for a given application. Power Kleen chemicals have 100% concentrated active ingredients. The reason MART compounds remain active longer is that they contain NO fillers. Other chemical suppliers may "fill" or bulk up their chemistries with non-active ingredients that do nothing except fill up the chemical drum. These fillers end up as sludge in the bottom of the Power Washer and must be disposed of, thus adding to the disposal costs. Since MART Power Kleen is fully active chemistry 100% of the chemical goes to work cleaning your parts. As a result, your cleaning dollar goes further and your disposal costs are less.

1.9 Recommended Chemicals

Power Kleen I – Iron and Steel
Fast acting, long lasting Power Washer detergent for removing heavy oils and grease, many types of carbon, and other deposits from all ferrous metals.

Power Kleen II – Aluminum Safe

Multi-Metal, biodegradable Power Washer detergent for removing oil, grease and dirt from both ferrous and non-ferrous materials.

Power Kleen IIIP – Electric Safe
Powdered Power Washer detergent for removing oil, grease and dirt from electric motors, generators, etc. Rinses completely with no conductive residue.

Power Kleen IIIL – Electric High-rinse
Liquid Power Washer detergent for removing oil, grease, and dirt from electric motors, generators, etc. Highest rinsability factor with no conductive residue.

Power Kleen IV – Aerospace
Specially formulated Power Washer detergent for removing carbon, grease, and dirt from Aerospace Metals, Aircraft Parts, and chemically sensitive space age metals.

The MART Corporation web site www.martwash.com is a vast information base for cleaning chemistry and has complete information for the entire Power Kleen line of chemicals. At the site you may download MSDS sheets for each product and find more in depth application data for each product. Optionally, you may call MART Chemical Sales and Technical Services staff who are trained to help customers select the most appropriate product for their specific cleaning applications and answer questions regarding chemical use and application.

2. Temperature Adjustment

The recommended maximum temperature operating points are shown in the following figure. ***NOTE:*** *The set point on the controller can differ from the actual temperature.*

Maximum Actual Operating Temperature

Altitude in Feet	*Temperature* ° F
0 - 2000	190° F ((88° C)
2000 4000	185° F (85° C)
4000 5000	180° F (82° C)
5000 and above	call MART

WARNING! Do NOT exceed recommended settings, or serious damage can occur to the wash pump (cavitation).

Fig. 4 - 1: Maximum Actual Operating Temperature

The temperature controller is located inside the electrical control panel. Refer to the following figure.

WARNING! Disconnect power before opening the control panel.

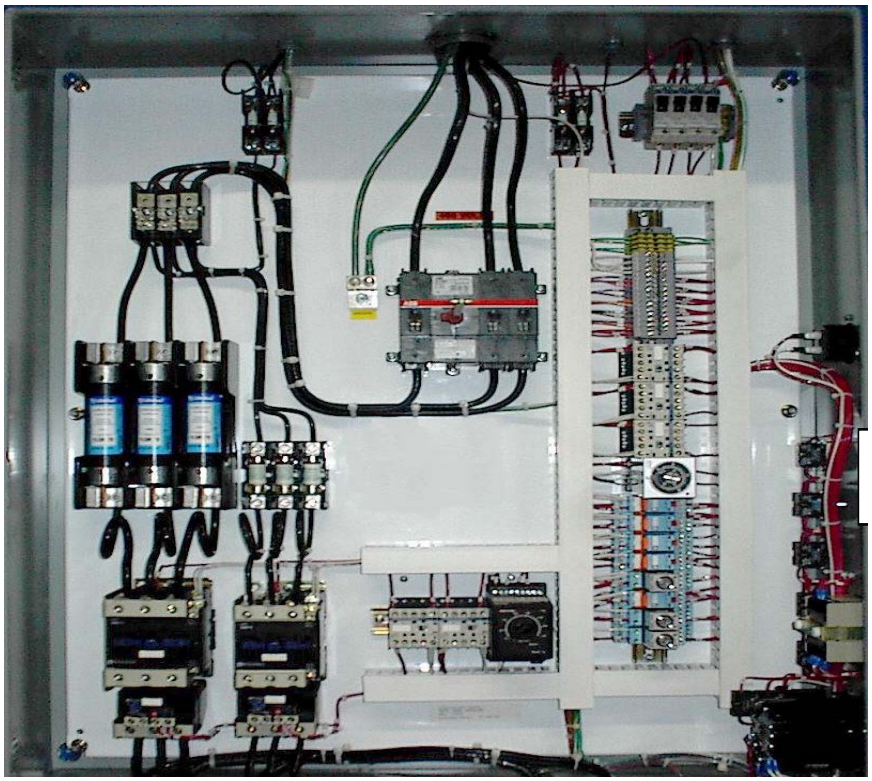


Fig. 4 - 2: General Layout of the Electrical Control Panel (Block Diagram)

Since temperature is only one of the variables that affect cleaning results, no general rule can be given for the temperature setting. You must test and adjust temperature, as well as other variables, to determine the optimum. Start with the recommendation of your MART Service Tech or your chemical supplier.

***Guidelines*:**

As temperature increases, greases and oil become more fluid. Since grease is the primary binder that holds and contains the soils on the parts, heat melts the binder generally producing better cleaning results. *Do not exceed recommended temperatures shown in Fig. 4-1, however, or the main wash pump may sustain severe damage due to cavitation.*

Use the following table as a guide in testing and adjusting temperature:

Temperature	***Type of Soil***
140-160 °F (60-71° C)	Light oils
160-175°F (71-79° C)	Greases
175°F + (+79° C)	Carbon, Paint

NOTE:

- Higher temperatures use more energy.
- Higher temperatures will allow a longer rinse cycle, due to greater evaporation.

3. Rinse-System Control (optional ARC)

The Automatic Rinse System (ARC) is a fresh-water rinsing system. It is powered by waterline pressure. It allows the operator to control rinse characteristics and the application of a rust inhibitor by means of the chemical injector pump.

The following controls rinse time:

- Amount of makeup water needed, due to water loss through evaporation or drag-out.
- Automatic rinse system (ARC) timer

In controlling rinse cycle time, water loss takes priority. The amount of makeup water required determines the maximum rinse time allowed, if any.

Set rinse cycle duration by adjusting the automatic rinse cycle (ARC) timer, located in the electrical control panel. Refer to Fig. 4-2.

WARNING! Disconnect power before opening the control panel to make adjustments.

3.1. Setting the Rinse Timer

The rinse timer is an adjustable timer with a range of 0-10 minutes.

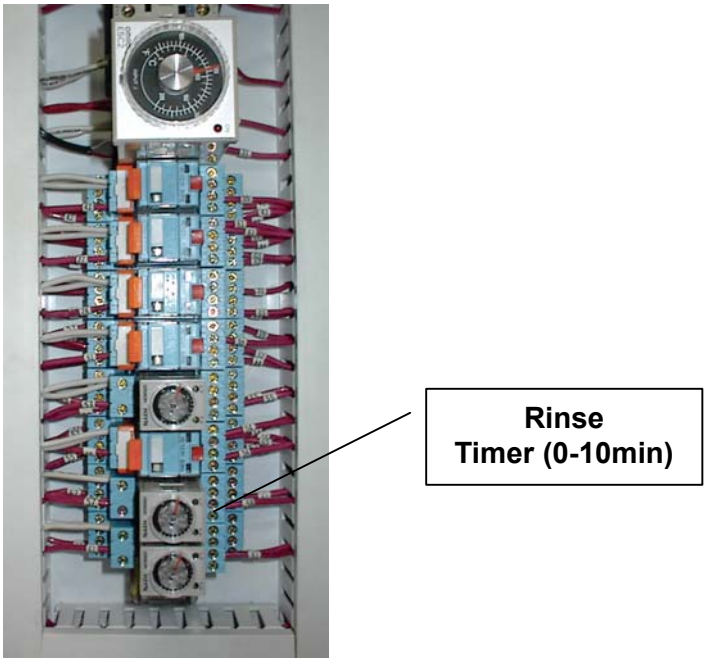


Fig. 4 - 3: Automatic Rinse Cycle (ARC) Timer Increments

If you find that your rinse is not long enough, consider operating at a higher temperature in order to evaporate more water during the wash cycle. Also, be sure that the auto steam exhaust (ASE) is removing steam -- moving up to the next ASE motor size may be an answer.

3.2. Rinse Injector Pump

The chemical injector pump allows adjustment of the flow rate of chemical injected into the rinse water. It delivers liquid additive at very precise dosage rates (per minute). The regulator and gauge allow the operator to adjust the rinse spray characteristics of flow and pressure.

Contact your chemical supplier for the appropriate inhibitor chemical, and for instructions on using it.

> **NOTE**: Monitor inhibitor-chemical usage visually. Replace drums as needed to ensure that inhibitor chemical is applied with each rinse.

Before you operate the rinse system, you need to make the two following adjustments.

To adjust the chemical concentration in the rinse water (chemical injector pump), *follow this procedure*:

1. Determine the number of nozzles your washer has for its rinse system (in order to use the correct graph to achieve the desired rinse-regulator pressure). Your washer will have 3, 4, or 5 rinse nozzles.

2. Select the proper graph. (Refer to the following figures in this section.)

> **NOTE:** The graphs are for a 1.06 gal/hr (4 l/hr) injector pump, MART #50107; and 50° .053-inch (1.3 mm)-diameter-orifice nozzles, MART #29010.

3. Determine the rinse-regulator pressure your washer currently uses in the rinse cycle.

NOTE: MART sets the washer's rinse-regulator pressure to 30 PSI (208 kilopascals) at the factory. However, your washer's pressure may differ, depending on the incoming water-supply pressure.

4. Change the pressure, if you wish.

5. Determine the chemical mix ratio, *in ounces per gallon (oz./gal.)*, that you require for the rinse solution concentration.

6. On the graph you have selected, find the correct *Mix Ratio (OZ/GAL)* on the horizontal axis.

7. Based on the rinse-regulator pressure you selected for your washer's rinse operations, find the correct rinse-regulator pressure *line on the graph*.

NOTE: There are five rinse-regulator pressures represented on each graph. Refer to the "key-code" box under the graph to select the correct line, based on your rinse-regulator pressure.

8. Trace a straight line from the *Mix Ratio (OZ/GAL) point on the horizontal axis* **up** to a *point on the correct pressure line*.

9. From the *point on the pressure line*, trace a straight line **left** over to a point on the vertical axis. The point on the vertical axis represents the percent of full output at which you should set the rinse injector pump to achieve the required mix ratio.

10. Find the injector pump's control knob.

11. Set this knob to the percent of full output.

NOTE: The control knob is divided into 12 segments. Each division represents 8.33% of full output.

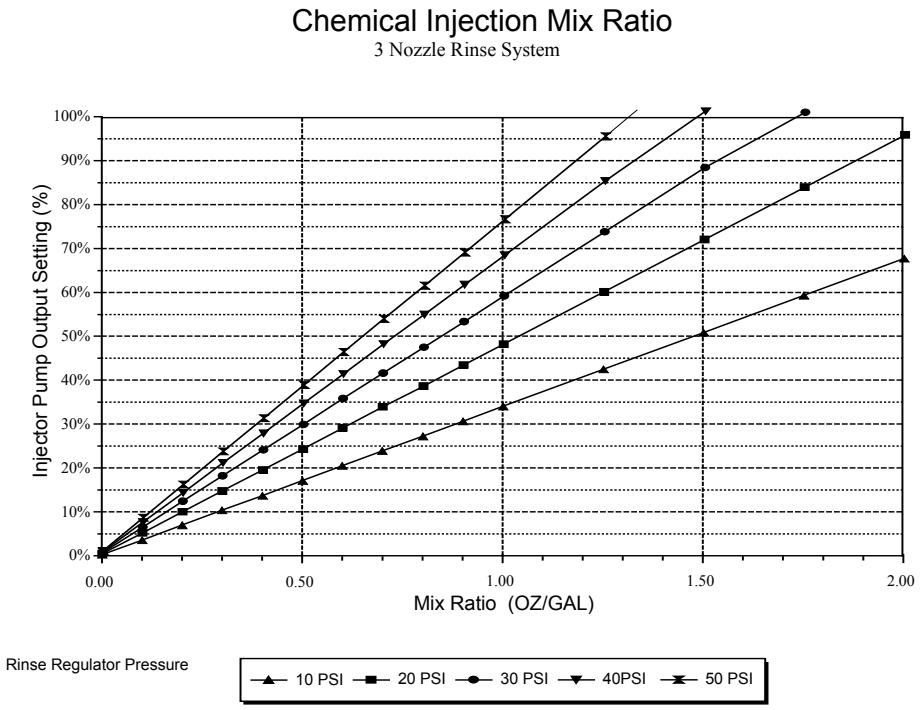


Fig. 4 - 4: Injector Pump Output Setting: 3-Nozzle Rinse System

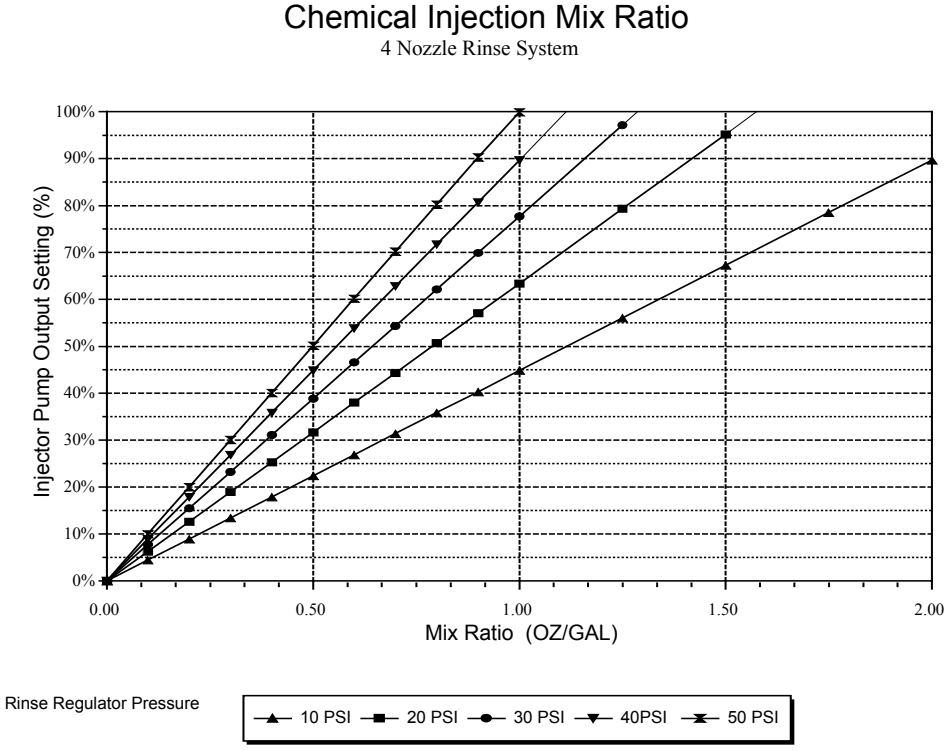


Fig. 4 - 5: Injector Pump Output Setting: 4-Nozzle Rinse System

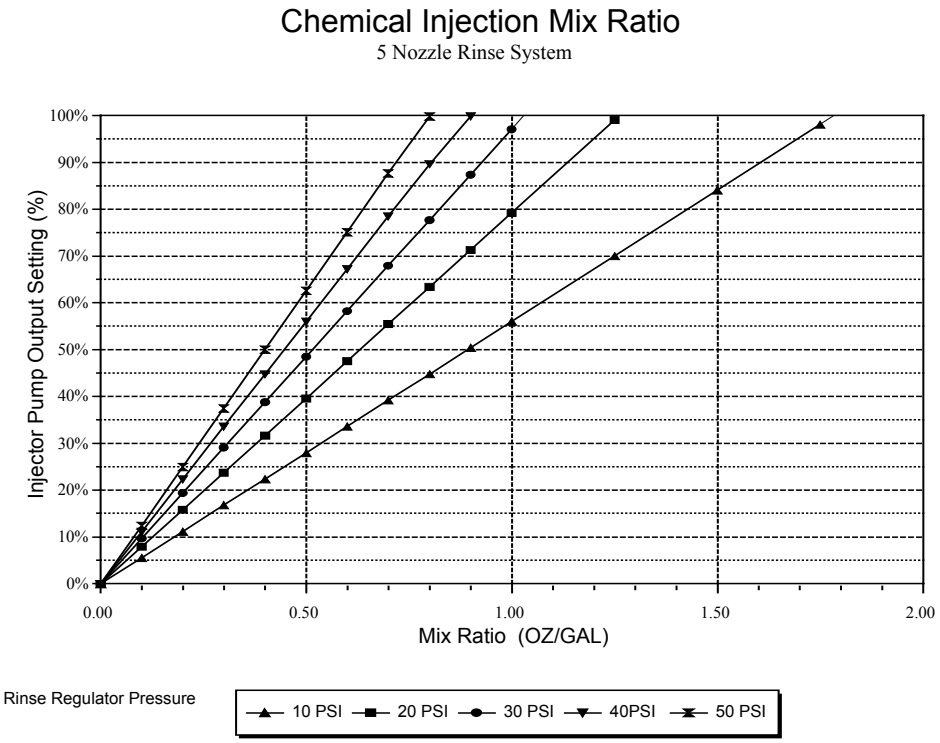


Fig. 4 - 6: Injector Pump Output Setting: 5-Nozzle Rinse System

3.3 Rinse Water-Flow Adjustment

To operate the water regulator, *follow these guidelines*:

NOTE: The regulator is factory pre-set. Adjust it to achieve rinse characteristics that meet your requirements.

To Get This:		**Adjust the Regulator for**:
Smaller drops, more volume	➔	Higher gauge reading
Larger drops, less volume	➔	Lower gauge reading

Generally, medium settings (30-35 PSI [208 - 242 kilopascals) give the best results.

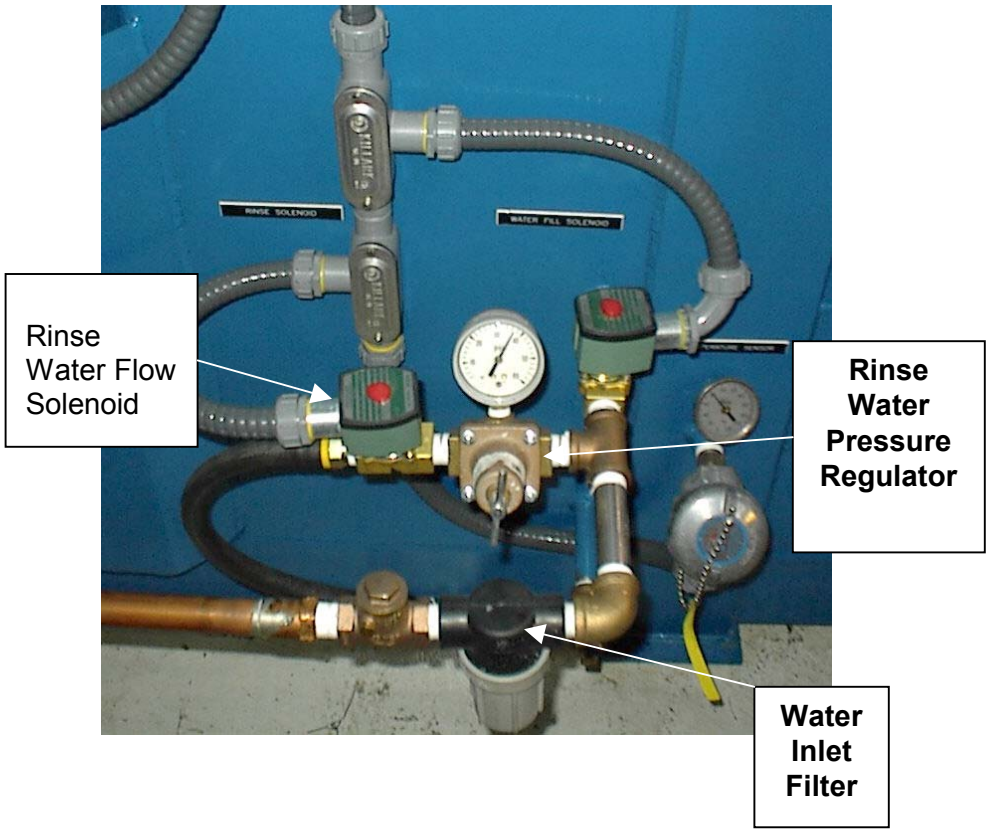


Fig. 4 - 7: Rinse water flow adjustment

4. Setting the 7-Day Dual-Circuit Clock

The 7-day clock is a programmable digital dual-circuit clock that allows you to pre-set the days of the week and the time of day for the washer to:

- Heat up/water-fill
- Remain in "shut-down" (*off*) mode
- Program "run" times for optional devices

The clock is located on the face of the electrical control panel, as shown in the following figure. **Circuit #1** controls the heating and water-fill times. **Circuit #2** controls the "auto" runtime for optional devices such as the Clean Machine and the Oil Skimmer.

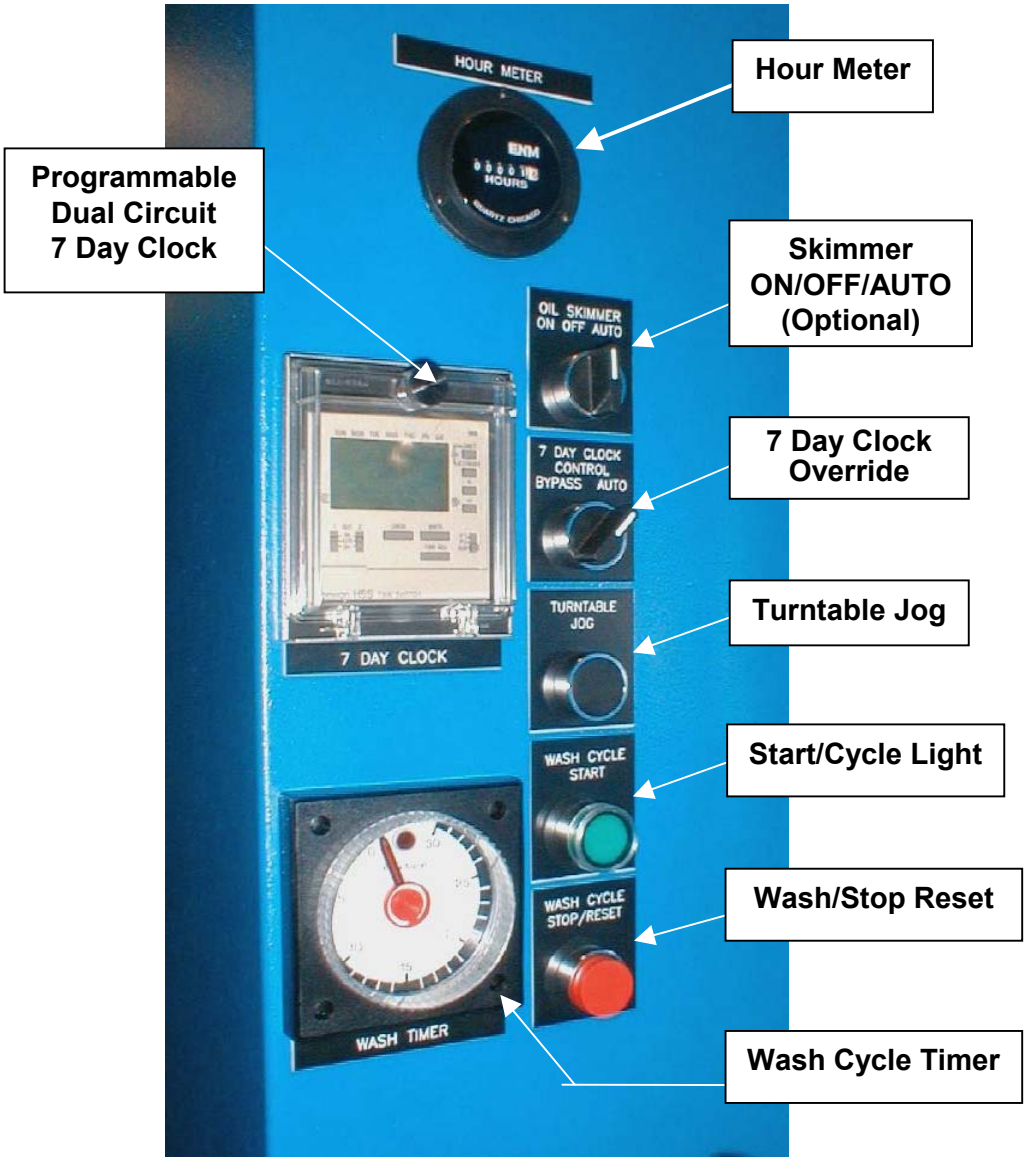


Fig. 4 - 8: Standard Turntable Power Washer Control Panel

Refer to your vendor-provided manual bound into the back of this manual for instructions on setting the clock.

CAUTION! If the main power supply is OFF for a time period that exceeds the power-outage carry-over specified in the vendor-supplied 7-day dual-circuit clock manual, be sure to reset the 7-day dual-circuit clock.

4.1. 7-Day Dual-Circuit Clock and Optional Devices

A separate manual/off/auto switch controls some optional devices, such as the Clean Machine and the Oil Skimmer, and circuit #2 of the 7-day dual-circuit clock, located on the face of the electrical control panel.

In order for these devices to work in "automatic mode," *follow this procedure*:

1. Program the 7-day clock's circuit #2 for the operating runtime (day of week, start time, and stop time).

2. Set the device's *manual/off/auto* switch to *auto*.

NOTE: ***If you omit step #1,*** devices that are controlled by a *manual/off/auto* switch will *not* work when you set the switch to *auto.* (You can, however, run such devices manually by setting the switch to *manual*.)

For more information on operating options that you have purchased from MART, refer to chapter *"Options."*

5. Steam-Exhaust Timer

The steam-exhaust timer controls the length of time that the automatic steam exhaust (ASE) operates after the end of the wash or rinse cycle. The timer is located inside the electrical control panel. Refer to Fig. 4-2.

How the ASE cycle actually works depends on your washer's configuration:

ARC (optional) If your washer is equipped with the optional automatic rinse cycle (ARC) the automatic steam exhaust (ASE) cycle removes steam from the washer cabinet:

- During the wash cycle
- During the optional automatic rinse cycle (ARC)
- For the ASE timer-set period of time *after* the automatic rinse cycle (ARC) cycle has completed

No ARC If your washer is *not* equipped with the optional automatic rinse cycle (ARC), the automatic steam exhaust (ASE) cycle removes steam from the washer cabinet:

- For the ASE timer-set period of time *after* the wash cycle has completed

5.1. Setting the ASE Timer

The steam exhaust timer is an adjustable 0-10 minute timer.

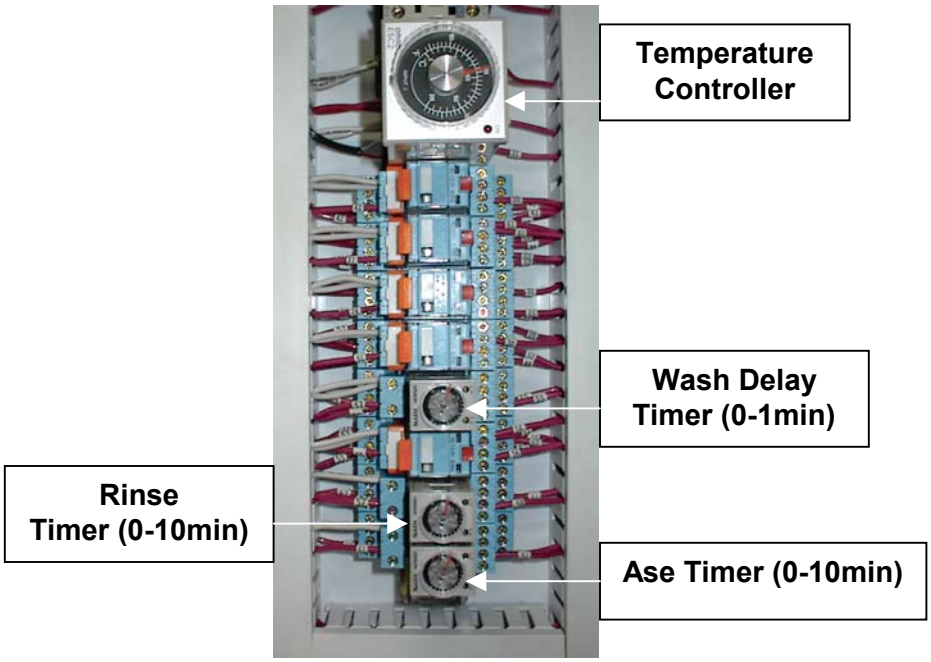


Fig. 4 - 9: Automatic Steam Exhaust (ASE) Cycle Timer Increments

Many factors affect optimal run-time for the ASE cycle. For example:

- Operating temperature of the power washer
- Atmospheric pressure
- Feet above sea level at the installation site

To test for the most effective ASE cycle, *follow this procedure*:

1. Start by setting the ASE timer to 5 minutes.
2. Run the ASE cycle.
3. Check to see if any steam remains in the cabinet after the ASE cycle has completed.
4. Increase or decrease the ASE timer by one-minute increments. (Generally, if steam remains in the cabinet, increase the timer by one minute.)
5. Repeat steps #2 - #4 until the cabinet is purged of steam.

WARNING! When you run this test, do not open the washer cabinet door until the automatic steam exhaust (ASE) cycle has completed. Steam can contain chemical used in the wash cycle. Refer to your chemical supplier's warnings about the chemical you use.

NOTE: When the *start* button light goes out, the ASE cycle has finished.

6. Monitoring

You must set up a monitoring schedule for washer assemblies and parts. Start with the following:

- Lubrication
- Sludge build-up
- Intake filter
- Amp draw & nozzle wear

Use the *Service Schedule* on the front of the control-panel door as a guide in establishing a monitoring schedule.

> **NOTE**: It is important to keep a monitoring record -- post it on the side of the washer or on the door. Have operators initial the record each day after monitoring, and indicate if any maintenance procedures need to be performed.

Refer to chapter *"Maintenance"* for maintenance procedures.

6.1. Monitoring Lubrication

Monitoring lubrication of the following *on a daily basis* is extremely important for reliable washer performance:

- Turntable bearings
- Power blast manifold (PBM) swivel (*joint and upper bearing*)
- General lubrication (bearings, motors, and pumps)

Assemblies and parts need to be greased or oiled based on the hours of operation. Refer to the *Service Schedule* on the front of the control-panel door.

> **NOTE**: It is important to keep a lubrication record -- post it on the side of the washer or on the door. Have operators initial the record each day after completing lubrication procedures.

6.2. Other Monitoring

In addition to monitoring lubrication, include the following on your initial monitoring schedule:

- Sludge build-up (daily)
- Pump intake filter (daily)
- Amp draw & nozzle wear (monthly)

General Guidelines:

Sludge Monitor daily. Clean out *sludge* when there is about 4 inches (10.16 cm) of it on the bottom of the front reservoir.

Pump Intake Filter Monitor daily. Clean the *pump intake filter* every 8 hours of operation to remove sludge and other material plugging it.

Amp Draw/Nozzles Monitor the *amp draw at the wash pump* on a *monthly* basis to detect nozzle wear. (Nozzle wear is not always visible.)

Perform maintenance procedures based on the hours of operation. Refer to the *Service Schedule* on the front of the control-panel door.

Refer to chapters *"Maintenance"* and *"Troubleshooting"* for more information.

5 Maintenance

Purpose

This chapter discusses the maintenance of your MART Power Washer. In general, the washer is *not* maintenance-intensive. A few key items, however, need regular, scheduled care: Use the information in this chapter to establish and follow a service schedule.

Good maintenance is essential for cleaning results, and long economical life of the washer.

Prerequisites

Before you read this chapter, we recommend that you read the following thoroughly:

- *"Important Safety Instructions and Warnings"* (in the front material)
- Chapter 1, *"Overview"*
- Chapter 4, *"Advanced Operations: Process-Control"*

Safety/Precautions

Before you perform maintenance on the washer, read and follow these recommended safety/precaution instructions:

> ***WARNING! NEVER get inside the washer cabinet when the main power supply is ON. This could result in severe injury or death.***

> ***WARNING! Turn the main power supply OFF before opening the electrical control panel!***

WARNING! Be sure that people performing maintenance are qualified and trained for the task.

CAUTION! You must turn the main power supply OFF before performing many maintenance procedures. BE SURE to turn the main power supply back ON after you perform maintenance.

CAUTION! If the main power supply is OFF for a time period that exceeds the power-outage carry-over specified in the vendor-supplied 7-day clock manual, be sure to re-set the 7-day clock (located inside the electrical control panel).

WARNING! Do NOT OVERLOAD the false floor or other horizontal surfaces. The false floor is intended as a chemical-solution cover ONLY! Horizontal surfaces are NOT designed for walking or standing! Walking on the false floor, tank cover, or other horizontal surfaces could result in serious injury or death.

What You Will Learn In This Chapter

In this chapter you will learn the following about maintenance:

- Service schedule, based on hours of washer operation
- Performing maintenance and common washer adjustments
- Sludge monitoring and clean-out
    - Heat-exchanger and suction tube (cleaning)
    - Heating elements (cleaning)
- Maintenance of options

1. Service Schedule

Your washer comes with a maintenance *Service Schedule* along with the MART Power Washer Manual located in a white pouch inside of the main electrical-control-panel. The following figure shows part of the schedule, organized by hours of washer operation. Maintenance procedures for items in the schedule follow, and are grouped by washer systems and assemblies. *Use the **Hour Meter** on the washer's control panel to schedule maintenance by hours of operation.*

Service Schedule		
Frequency	**Date**	**Technician**
8 Hours (At the end of every shift)		
Wash Pump Intake Filter (inspect/clean)	_____	_____
(NOT Cyclone 30's and Tornado 40's only)		
Turntable Bearings (grease; Lubriplate 1444)	_____	_____
PBM Swivel Joint (grease; Lubriplate 1444)	_____	_____
Sludge Level (monitor)	_____	_____
40 Hours (Weekly)		
PBM Nozzles (inspect/monitor)	_____	_____
Chemical Concentration (test)	_____	_____
Slip Clutch/Torque Limiter (inspect)	_____	_____
160 Hours (Monthly)		
PBM Swivel (inspect/adjust)	_____	_____
Air Intake - Burner Blower Motor (clean)	_____	_____
Amperage Draw at Wash Pump(s)(measure)	_____	_____
Turntable Drive Bearings (grease; AW2)	_____	_____
Upper Manifold Bearing (grease; AW2)		
1100 Hours (6 Months)		
(Cyclone 30's and Tornado 40's only)		
Turntable Bearings (grease; Lubriplate 1444))	_____	_____
Voltage at Power Distribution Block (measure)	_____	_____
Door Bearings (grease; AW2)	_____	_____
Wash Pump and Pump Motor (grease; AW2)	_____	_____
Float Assembly (inspect/clean)	_____	_____
ASE Blower Motor (oil)	_____	_____
Burner Blower Motor (oil)	_____	_____
Water Solenoid Valves (clean or replace)	_____	_____
Wash Pump Couplings (inspect)	_____	_____

Fig. 5 - 1: Service Schedule

2. Performing Maintenance and Common Washer Adjustments

This section gives maintenance instructions and common washer adjustments for items listed in Fig. 5-1, except sludge monitoring and clean-out, which is in section 3. Items are grouped by washer systems and assemblies.

2.1. Pumps and Power Blast Manifold (PBM) Assembly

This section describes maintenance procedures for the following:

- Wash pump intake filter (inspect/clean)
- PBM swivel joint (grease; Lubriplate 1444)
- PBM nozzles (inspect/monitor)
- PBM swivel jam nut (inspect/adjust)
- Amperage draw at wash pump (measure)
- Upper manifold bearing (grease; Mobilith AW2)
- Wash pump and pump motor (grease; Mobilith AW2)
- Wash pump couplings (inspect)

2.1.1. Wash Pump Intake Filter (Inspect/Clean)

Follow this procedure (refer to the following figure):

> ***CAUTION! Do not remove the pump intake filter box from the reservoir.***

1. Remove the front reservoir cover.
2. Clean the pump intake filter box with a stiff-bristle wire brush. (The filter box is located at the bottom-front-left corner of the reservoir.)
3. Run the brush across the top, back, and right hand-side of the filter box to remove sludge and gasket material.
4. Replace the reservoir cover.

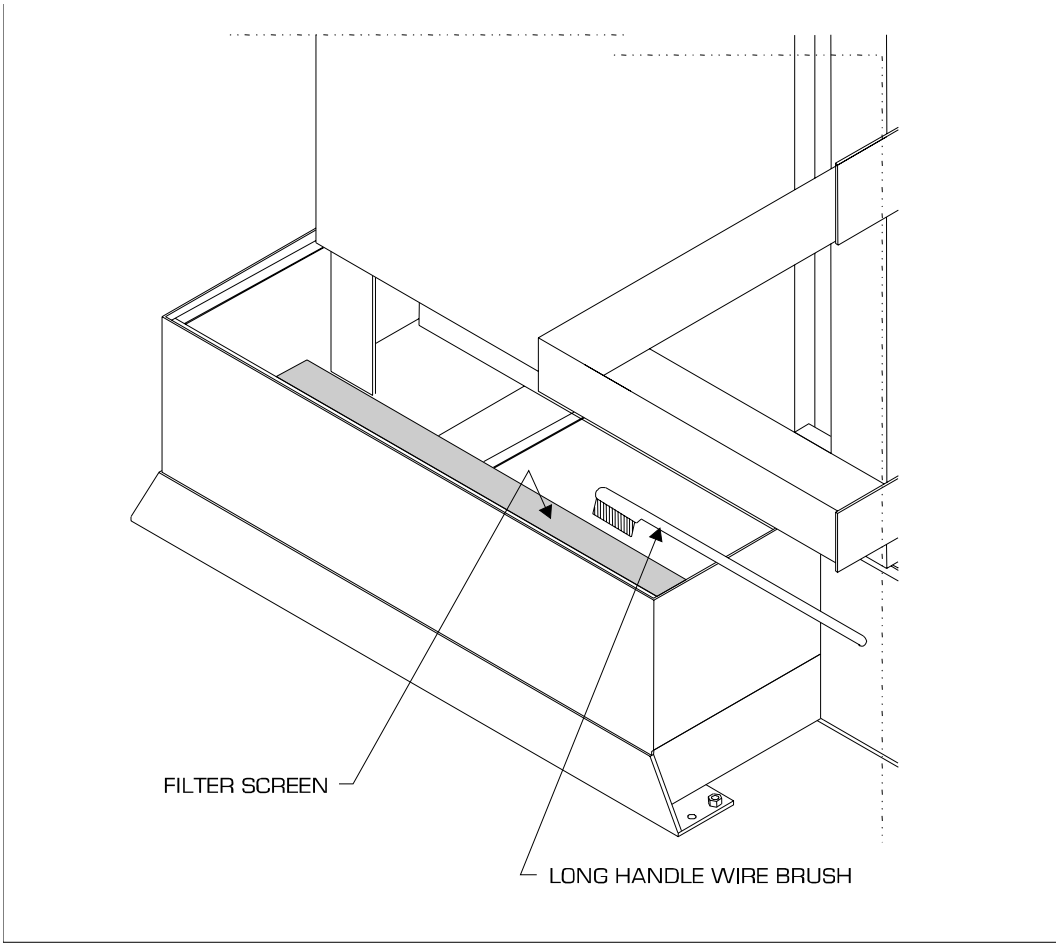


Fig. 5 - 2: Cleaning the Pump Intake Filter Box

2.1.2. PBM Swivel Joint (Grease)

Grease the PBM Swivel Joint with Lubriplate 1444. Refer to the following figure.

> **NOTE**: It is ***imperative*** that the PBM swivel be greased every 8 hours of operation!

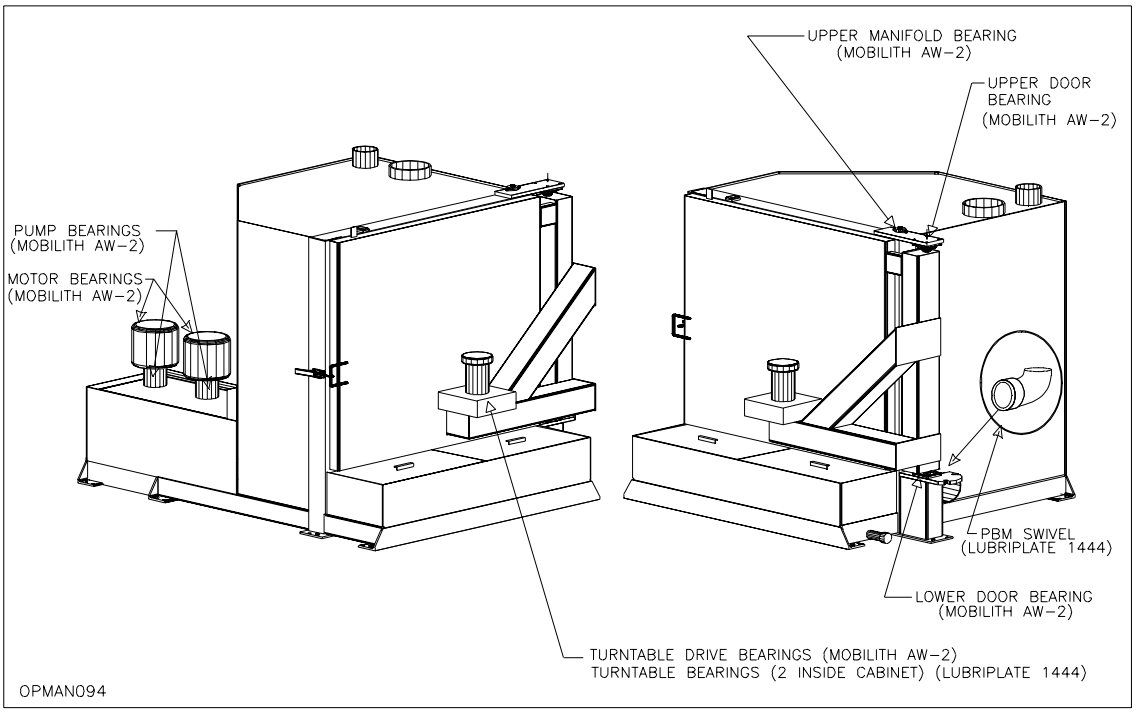


Fig. 5 - 3: Lubrication Chart

2.1.3. PBM Nozzles (Inspect/Monitor)

Inspect the PBM wash-and-rinse nozzles for clogging and alignment. The flat-spray nozzles are aligned with "punch" marks on the manifold to ensure an overall uniform coverage, which gives you the best cleaning results. When you check for clogging, be sure to check that all nozzles are correctly aligned, as indicated in the following figure.

Monitor the amperage draw at the main wash pump(s) to check for worn nozzles: A higher amperage draw than normal (check your baseline readings) indicates that nozzles may need to be replaced. Remember that a worn nozzle is not always visually apparent -- nozzle tips can look fine, but actually be quite worn. Since a worn tip can spray at up to 30% over capacity, amperage draw will be higher.

If nozzles need to be cleaned or replaced, *follow this procedure*:

> ***WARNING! Do not stand or walk on the false floor inside the cabinet, or on the reservoir cover.***

1. Turn the *main power supply OFF*.
2. Remove the nozzle with a 9/16-inch (14 mm) wrench.
3. Remove any debris.
4. Apply 6 –7 turns of teflon tape to the threads.
5. Re-install the old nozzle, or install a new one. Thread nozzle finger tight and snug up with wrench 1 to 1-1/2 turns. Observe alignment "punch" marks on the PBM, and align the "V" slot in the nozzle with the marks. Do not over tighten. Refer to the following figure.

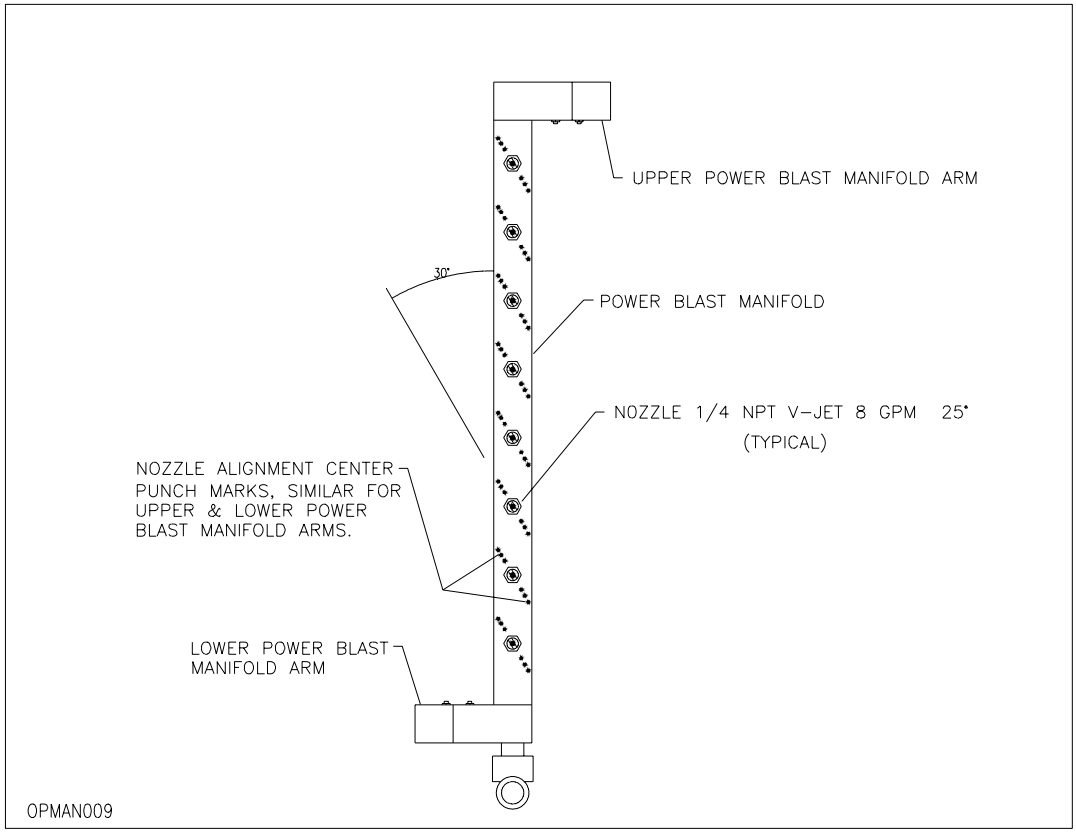


Fig. 5 - 4: Cleaning and Replacing the PBM Nozzles

2.1.4. PBM Swivel (Inspect/Adjust)

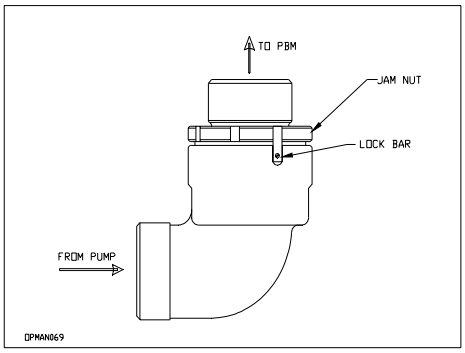
Inspect the PBM swivel to be sure it is rotating freely.

Follow this procedure:

1. Turn the *main power supply OFF*.
2. Disconnect the *PBM linkage* from the *PBM upper bearing/shaft*.
3. Open the washer cabinet *door.*
4. Push the *manifold* back and forth. *If* it does not move freely, *and if* you have been greasing the manifold regularly, you need to adjust the jam nut. The jam nut is located on the swivel at the bottom of the PBM manifold. The swivel assembly allows for take-up of the packing after it wears.
5. Swivels with *Jam Nuts* only: Adjust the *PBM swivel jam nut* so that it swings freely, but is as tight as possible in order to prevent leaking around the joint.

   Follow this procedure:

   - Remove the lock bar.
   - Screw the nut clockwise to the next locking slot (until compression on the packing causes the nipple to rotate with a mild amount of torque).
   - Re-install the lock bar.
   - You may repeat this process until the packing has worn too badly to keep a tight seal.



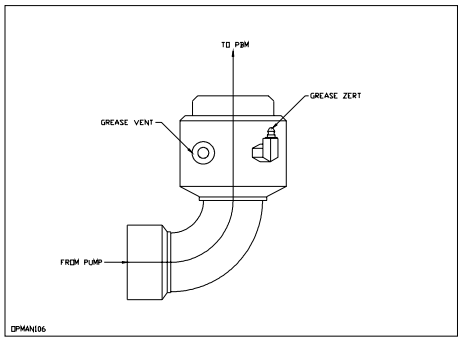


Fig. 5 - 5: Swivel Jam Nut **Non-adjustable swivel**

2.1.5. Amperage Draw at Wash Pump(s) (Measure)

Measure and record the amp draw from the wash pump motor(s), using a clamp-on amp meter.

> ***CAUTION! Be sure that ONLY a qualified electrician performs this maintenance task!***

> **NOTE**: Take the amperage measurement at the load side of the wash pump starter(s) on each power leg. If the washer is equipped with a duplex pump system, take amp readings separately on each wash pump motor, with both pumps running.

Compare amperage readings with the maximum amp load, which is calculated as follows:

> On each pump motor, find the manufacturer's specification tag. The tag indicates two things: **(1)** Full-load amperage draw at your specified voltage; *and* **(2)** The service factor, which is either 1.15 or 1.25 times the full-load amperage, depending on motor size and incoming voltage.
>
> Multiply the full-load draw (as indicated on the motor tag) by the service factor in order to calculate the maximum allowable amp load.

The actual amperage draw reading on each motor is to fall below the maximum calculated allowable amp load.

If the actual amperage draw reading exceeds the maximum calculated allowable amp load, this could indicate that nozzles are worn and need to be replaced, or that there are some other leaks in the system. Refer to section *"PBM Nozzles"* above, and to chapter *"Troubleshooting/Wash Pump System."*

2.1.6. Upper Manifold Bearing (Grease)

Grease the PBM upper manifold bearing with Mobilith AW2. Refer to Fig. 5-3.

2.1.7. Wash Pump and Pump Motor (Grease)

NOTE: 10 HP wash pumps have no bearing grease points.

NOTE: Use Mobilith AW2 to grease the pump and the pump motor.

CAUTION! Overgreasing creates heat. Do NOT overgrease the pump or pump motor.

CAUTION! Too much lubricant is a major cause of premature motor failure. If you apply too much grease, it is eventually forced out of the bearing housing and begins dripping on the motor windings. The grease then attacks and destroys the insulation, resulting in early motor failure.

CAUTION! Use ONLY a manually operated grease gun. Do NOT use a power grease gun.

To grease the pump, *follow this procedure*: (refer to the following figure)

1. Turn the *main power supply OFF*.
2. Remove the *plugs* opposite the *grease fittings* on both ends of the bearing frame.
3. Clean the *grease fittings*.
4. Use a *manually operated grease gun* on the fittings.

5. Add approximately *1 ounce (2.9 ml) of fresh grease* for each *bearing* (which is about *2-3 hand-pumps of grease* for each *bearing*).

6. Replace the *fittings* and *plugs*.

7. Turn the *main power supply ON*.

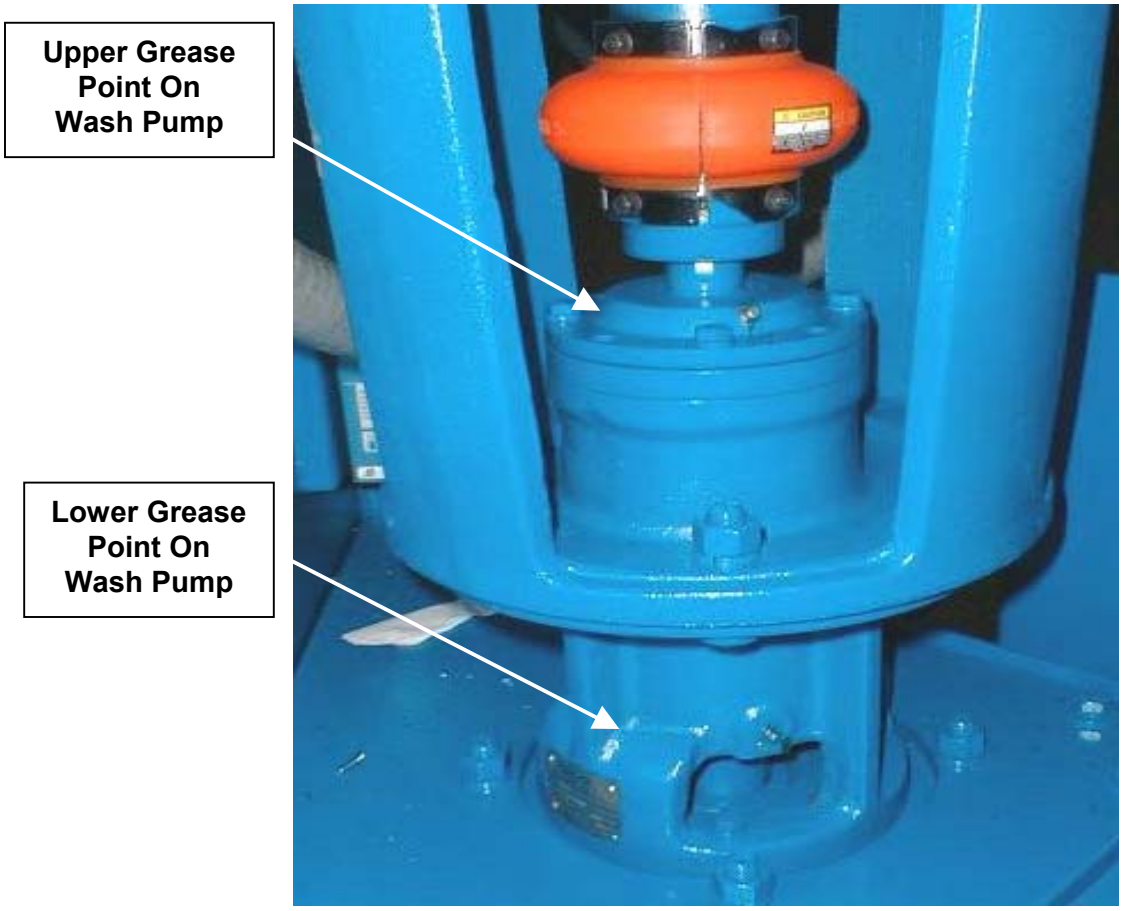


Fig. 5 - 6: Wash Pump and Pump Motor(s)

To grease the pump motor(s), *follow this procedure*: (refer to the previous figure)

1. Turn the *main power supply OFF*.

2. Clean the *grease fittings.*

3. Grease the wash pump motor point.

4. Use a *manually operated grease gun*.

5. Add approximately *1 ounce (2.9 ml) of fresh grease* (which is about *2-3 hand-pumps of grease*).

6. Turn the *main power supply ON*.

2.1.8. Wash Pump Couplings (Inspect)

Inspect the wash pump(s) couplings for the following:

- Wear
- Separation
- Misalignment

Refer to Fig. 5-6 as you inspect couplings for the following:

Wear If couplings are worn, replace them.

Separation If couplings are separated, loosen them and re-adjust their position.

Misalignment If couplings are misaligned, they are also probably worn or separated. Loosen the couplings and re-adjust their position. Also, check the bolts for tightness.

2.2. Heating System

This section describes maintenance procedures for the following:

- Air intake - burner blower motor (clean)
- Burner blower motor (oil)

2.2.1. Air Intake - Burner Blower Motor (Clean)

Clean the air intake on the burner blower motor (natural gas, L.P. gas, or fuel-oil fired burners only) with a compressed-air blower or a soft brush, in order to remove dust and dirt. Refer to the following figure.

2.2.2. Burner Blower Motor (Oil)

Oil the burner blower motor with a standard electric-motor oil, suitable for small electric motors. For example, 10W-50 SAE oil. Refer to the following figure.

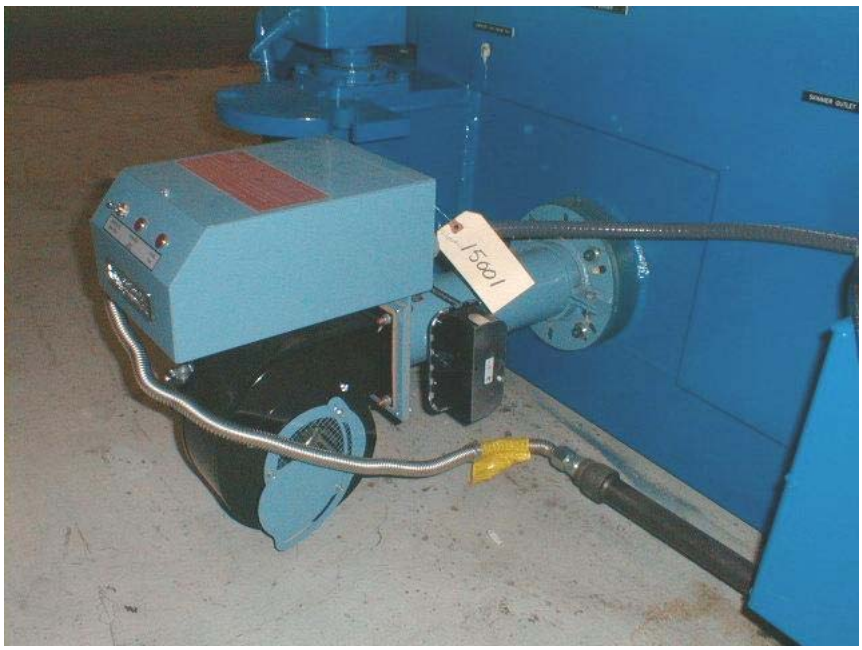


Fig. 5 - 7: Burner Blower Motor (380,000 BTU Burner Shown; Other Sizes Similar)

2.3. Water-Level Control System

This section describes maintenance procedures for the following:

- Float assembly (inspect/clean)
- Water solenoid valves (clean or replace)

2.3.1. Float Assembly (Inspect/Clean)

Inspect/Clean

Inspect the float assembly periodically. The single-ball float system normally requires little or no cleaning -- however, under some operating conditions, you may have to clean the operating rod and float ball.

Refer to the following figure to locate these parts:

- Check the *cam set screws* for tightness.
- Check the *float ball to rod connection* for tightness.
- Clean the *float ball*, if necessary.

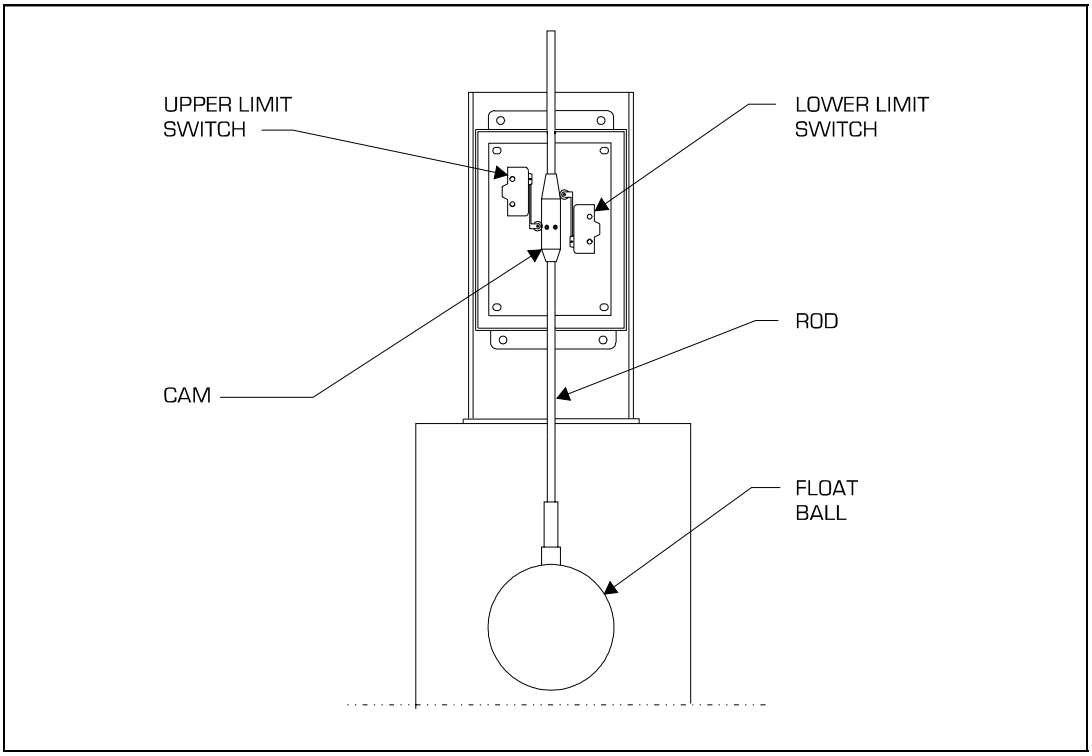


Fig. 5 - 8: Float Assembly

Making Adjustments ***(see chapter "Installation/Power-Up Procedure/Water-Level Control" for more information)***

If the water level is more than 1/8" above or below the water-level indicator, *follow this procedure*:

1. Remove solution until the solution level is below the set-point.

2. Let the washer fill automatically and shut off.

3. *If the water level is more than 1/8" inch above or below the water-level indicator,* you will need to adjust the cam on the float rod. Follow the steps below.

   Turn the power *OFF.*

   Remove the float-control box cover.

4. Mark the current location of the cam on the float rod with a marker or a piece of tape before making any adjustments.

   If the water-level measurement you made is higher than the indicator, you will need to move the cam **up** the float rod by the difference between the indicator and the measured value

   If the measurement is lower than the indicator, you will need to move the cam **down** the float rod by the difference between the indicator and the measured value.

   Measure the distance to the new position and mark it on the float rod.

   Next, loosen the two set-screws on the cam with an Allen wrench.

   Finally, slide the cam to the new location, and re-tighten **both** set-screws.

5. Turn power on to the washer and test the new level by allowing the washer to fill to the old set-point.

   NOTE: It will be necessary to remove water from the washer if the new level is lower than the new set-point.

   Verify that the set-point level is correct. If necessary, repeat the above steps until the set-point level is at the indicator, plus or minus 1/8" inch.

6. Replace the cover on the float box and tighten the four screws.

NOTE: If your washer has a rinse system, once operations have started water levels in the washer can be higher than the set-point water level. This happens whenever the washer automatically uses the rinse-bank for longer rinses.

To verify the correct set-point water level after operations have started, you must allow the washer to fill to the set-point. You can check this by observing the position of the float cam relative to the limit switches in the float box. (Refer to Fig. 1-3: Float-Level Mechanics) If the cam is higher than the set-point, you will have to remove solution from the washer and allow the washer to fill to the set-point to check set-point water level.

REMEMBER!! ***NEVER CHANGE*** **THE POSITION OF THE LIMIT SWITCHES** -- they are pre-set. For more information on the limit switches, refer to chapter *"Overview."*

2.3.2. Water Solenoid Valves (Clean or Replace)

Disassemble the water solenoid valves, and clean or replace the diaphragms with re-build kits.

Refer to your vendor-supplied cut sheet for instructions.

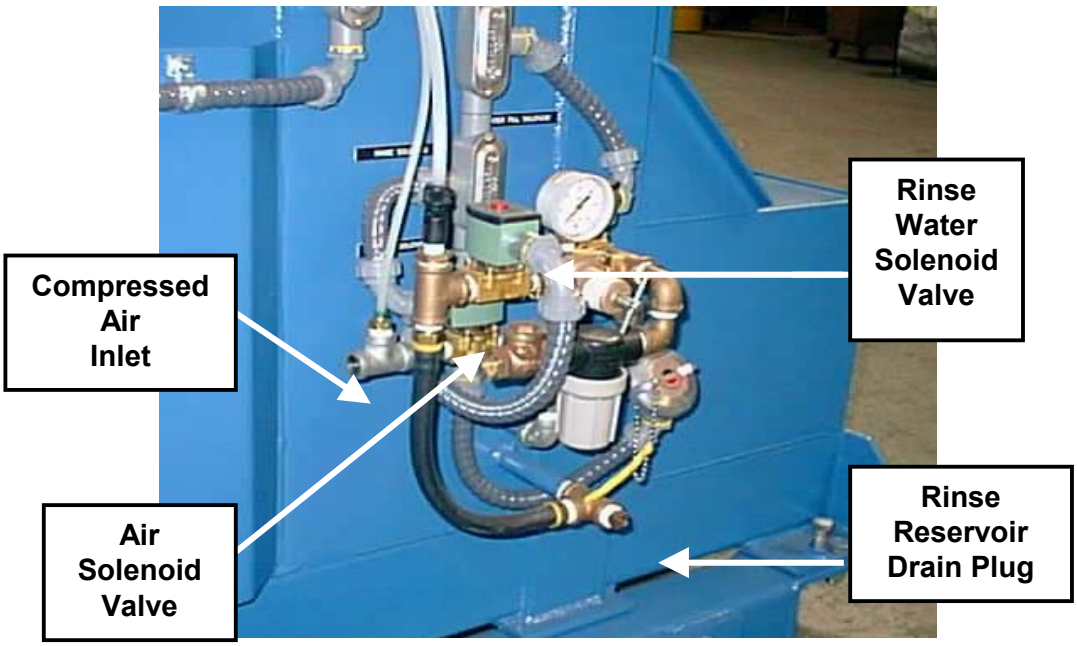


Fig. 5 - 9: Solenoid Valves

2.4. Turntable and Drive Assembly

This section describes maintenance procedures for the following:

- Turntable bearings (grease; Lubriplate 1444)
- Turntable drive bearings (grease; Mobilith AW2)
- Slip clutch/torque limiter (inspect)
- Door bearings (grease; Mobilith AW2)

2.4.1. Turntable Bearings (Grease)

Grease the upper and lower turntable bearings with Lubriplate 1444. Refer to Fig. 5-3.

> **NOTE**: It is ***imperative*** that the turntable bearings be greased every 8 hours of operation! (except Cyclone 30's and Tornado 40's

Pump in enough grease at each lubrication interval to completely fill the bearing. The quantity required will depend on the bearing size and other wash parameters which you set. As a rule of thumb when using a hand grease gun, pump until the grease gun feels "stiff" and then add an additional 2 or 3 pumps/squirts or until grease is visible at the seals.

Cyclone 30's and Tornado 40's Turntable roller bearings only.
Cyclone 30's and Tornado 40's have extended life bearings that require lubrication every 1100 hours of operation.
To lubricate the turntable roller bearings proceed as follows.
Remove the turntable. Remove the rubber seal from the top of the turntable spindle head. Locate zerk fitting and re-lubricate bearing with Lubriplate 1444 untill grease is visible around upper bearing nut. Replace seal and re-install turntable.

2.4.2. Turntable Drive Bearings (Grease)

Grease the turntable drive bearings with Mobilith AW2. Refer to Fig. 5-3.

2.4.3. Slip Clutch/Torque Limiter (Inspect)

The slip clutch is factory pre-set to 45 foot-pounds (6.2 kg-m), which is 5 foot-pounds (.7 kg-m) below the allowable motor torque. Slight slippage during washing is common and normal.

Inspect the slip clutch/torque limiter during operation of the washer. Under normal operation you may can see some slippage -- the sprocket jack shaft starts and stops while the motor shaft turns constantly. However, if the clutch slips constantly and nothing is jamming the turntable, you need to adjust the clutch.

You will need to remove the motor-drive assembly to adjust the clutch. Clamp the assembly on its side in a vise, or clamp it to a secure work surface, so that the sprocket can be rotated.

Follow this procedure: (refer to the following figure)

1. Devise a means of restraining the sprocket. (*For example:* Weld a nut to the bottom sprocket support plate. Use a nut that is appropriate for your torque wrench.)

2. Use a torque wrench with 50 foot-pound (6.9 kg-m) capability.

3. Loosen the set screws on the large hexagon torque-adjusting nut.

4. Restrain the torque-limiter threaded shaft at the motor. Use the torque wrench to turn the sprocket until the clutch slips.

5. Tighten or loosen the large hexagon torque-adjusting nut to adjust the clutch setting.

6. Set the max torque to 45 foot-pounds (6.2 kg-m) to slip the clutch.

7. Tighten the set screws on the large hexagon torque-adjusting nut.

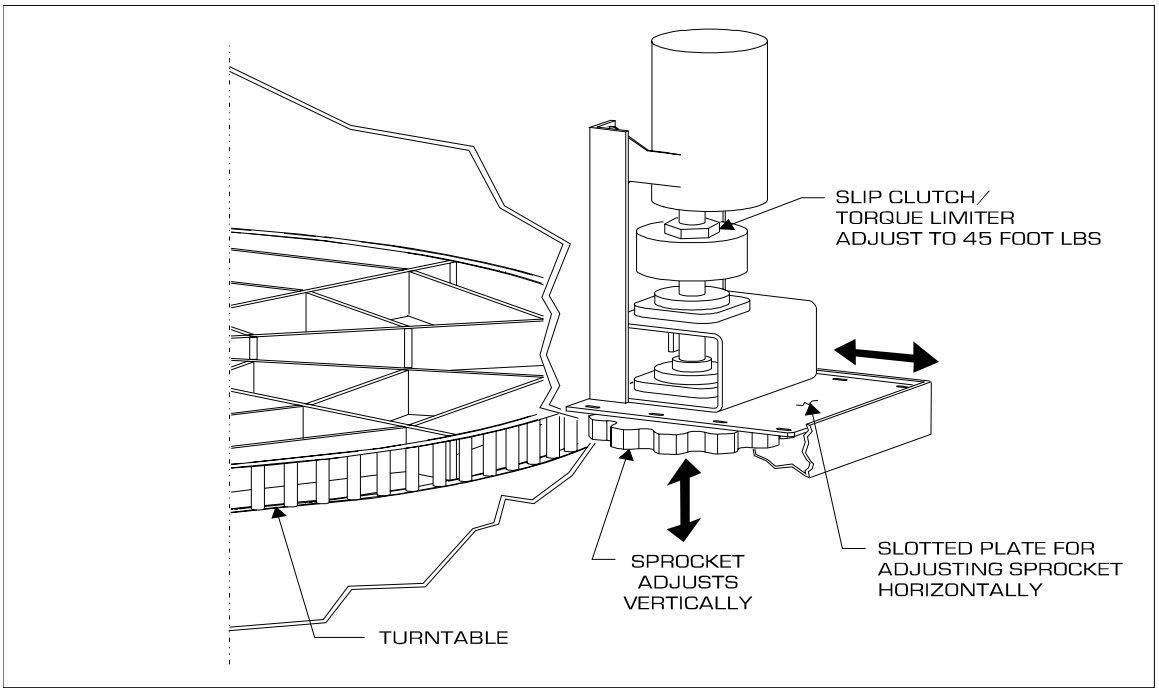


Fig. 5 - 10: Turntable Drive and Turntable: Slip Clutch/Torque Limiter

2.4.4. Door Bearings (Grease)

Grease the upper and lower door hinge bearings with Mobilith AW2. Refer to Fig. 5-3.

2.5. Auto Steam Exhaust (ASE) Assembly

ASE Blower Motors are lubricated for life. No additional lubrication is required.

2.6. Chemical Concentration

There are two methods to test chemical concentration and maintain the proper chemical charge:

1. **Titration Test**

   Titration is the estimation of the strength of a compound by measuring the amount of another compound of known strength that is required to produce an observable reaction.

   Almost all titration kits supplied with cleaning compounds use phenolphthalen (indicator P) as a reactant, and an acid (hydrochloric or phosphoric) as a neutralizer. The indicator P turns red or pink or blue when added to a sample of the solution. By counting the drops of acid it takes to turn the solution back to its original color, you can arrive at a good *estimate* of the chemical concentration.

   Titration Testing Guidelines:

   - Perform a titration test weekly.
   - Contact your chemical supplier for test kits.
   - Use a kit designed specifically for your chemical.
   - Follow test kit instructions.
   - Add chemical based on the results of the test.

   When you perform a titration test, do the following:

   1. Allow the sample solution to cool to room temperature.
   2. Filter the cooled solution to remove impurities.
   3. Hold the titration reagents vertical when you add drops to the sample. This ensures "size accuracy" of the drops coming out of the reagent bottles.

4. Use clean labratory flasks, vials, and bottles for all titrations. Dirty tools can produce invalid test results.
5. After testing the sample, pour it back into the washer.

For improved testing accuracy:

1. Prepare a "control" sample using fresh city water and chemical to the desired concentration.
2. Titrate this "control" sample.
3. Compare titrations of the wash solution to the results of the "control" in order to determine if you need to add chemical.

2. **Conductivity Test (optional)**

If your washer is equipped with optional conductivity-test instruments, refer to chapter *"Options,"* section *"Chemical Concentration Controller,"* for information on performing a conductivity test.

2.7. Voltage

This section describes maintenance procedures for the following:

- Voltage at power distribution block (measure)

2.7.1. Voltage at Power Distribution Block (Measure)

Measure and record the incoming voltage to the washer *with wash pump(s) running.*

CAUTION! Be sure that ONLY a qualified electrician performs this maintenance task!

NOTE: Take the measurements inside the electrical control panel, at the power distribution block. If the voltage drop is more than 10% below the voltage required for operation of the washer, call MART.

3. Sludge Monitoring and Clean-Out

This section describes maintenance procedures for the following:

- Sludge (monitor and clean out)
- Heat exchanger and suction tube (clean)
- Heating element(s) (clean - electric only)

Generally, when you clean out sludge, clean the heat exchanger and suction tube as well as the heating elements (if you have electric heat), since all require that the washer be emptied.

NOTE: Maintenance of heating elements may need to be done more often than sludge clean-out, or cleaning of the heat exchanger and suction tube.

WARNING! Do not stand or walk on the false floor inside the cabinet, or on the reservoir cover.

3.1. Sludge Monitoring

To monitor and measure sludge accumulation on the bottom of the reservoir, *follow this procedure*:

1. Remove the front-reservoir cover.
2. In the front-right corner of the reservoir, push a long stick vertically down to the reservoir floor.
3. Remove the stick.
4. Observe the sludge mark on the stick.
5. If 4 inches (10 cm) of sludge is indicated, clean out the washer.

3.2. Sludge Clean-Out and Heat Exchanger/ Suction Tube (Clean)

Clean the heat exchanger and suction tube when you clean out sludge, since both maintenance procedures require that the washer be emptied. If your washer uses

electric heat, clean the heating elements as well (see the following section for instructions).

Follow this procedure:

1. Turn the *main power supply OFF*.
2. Allow the *solution to cool* to room temperature.
3. Remove the front *reservoir cover*.
4. Use oil-absorbent pads or newspaper to *soak up floating oil and scum*.
5. Discard the pads by an *approved waste-disposal method*.
6. Pump the ***solution*** *into holding barrels*.

> ***CAUTION! Do NOT pump out the SLUDGE!***

7. Move the door position lock to allow the washer cabinet *door* to open to a 180° angle from the cabinet frame.
8. Remove the *false floor*.
9. Remove *sludge* from the bottom of the reservoir.
10. Dispose of the *sludge* by an approved waste-disposal method.
11. Clean under the *heat exchanger* with a stiff brush.
12. Flush out the *suction tube*.
13. Replace the *false floor*.
14. Position the door at a 90° angle from the cabinet frame.
15. Pump *solution* from the *holding barrels* back into the *reservoir*.

16. Replace the *front reservoir cover*.

17. Turn the *main power supply ON*.

> **NOTE**: The power washer controls will automatically fill the reservoir with the correct amount of water.

18. Perform a *chemical-titration test*, and add chemical as indicated by the test results.

19. Allow solution to heat up to operating temperature before running a wash cycle.

3.3. Heating Elements (Clean - electric only)

This procedure applies to electrically heated power washers *only*.

> **NOTE**: Maintenance of heating elements may need to be done more often than sludge clean-out, or cleaning of the heat exchanger and suction tube.

Follow this procedure:

> ***WARNING! Turn the main power supply OFF and allow solution to cool to room temperature before cleaning heating elements.***

1. Remove the front *reservoir cover*.

2. Pump the ***solution*** *into holding barrels*.

> **NOTE**: Empty solution to a level just below the heating elements.

3. Position the door at a 180° angle from the cabinet frame.

4. Remove the *false floor*.

5. Wire-brush or pressure wash the *heating element(s)*. Refer to the following figure.

6. After cleaning the heating element(s), pump solution back into the reservoir.

7. Re-install the false floor.

8. Turn the *main power supply ON*.

9. Allow solution to heat up to operating temperature before running a wash cycle.

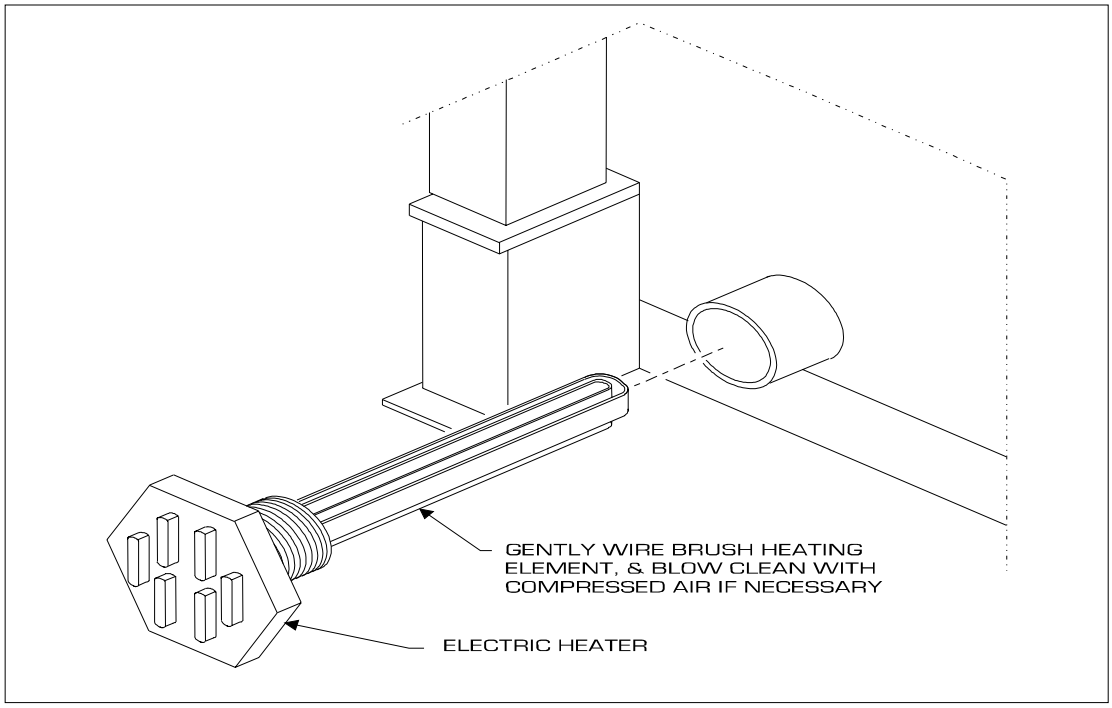


Fig. 5 - 11: Cleaning the Heating Elements

4. Maintenance of Options

For instructions on performing maintenance of options you have purchased from MART, refer to chapter *"Options."*

6 Troubleshooting

Purpose

This chapter contains information about troubleshooting the power washer. Key components are listed, along with symptoms of problems and their causes. In the unlikely event that your washer malfunctions, use this chapter to help diagnose and correct the problem.

In many cases, you can use procedures in chapters *"Installation," "Advanced Operations: Process-Control,"* or *"Maintenance"* to correct a problem after you have diagnosed it.

In other instances, refer to your vendor-supplied manuals or cut sheets for instructions on correcting problems.

Prerequisites

Before you read this chapter, we recommend that you read the following thoroughly:

- *"Important Safety Instructions and Warnings"* (in the front material)
- Chapter 1, *"Overview"*
- Chapter 4, *"Advanced Operations: Process-Control"*
- Chapter 5, *"Maintenance"*

Safety/Precautions

Before you take any corrective action or attempt to repair the power washer, read and follow these recommended safety/precaution instructions:

> ***WARNING! NEVER get inside the washer cabinet when the main power supply is ON. This could result in severe injury or death.***

> ***WARNING! Be sure that people who perform repairs are qualified and trained for the task.***

What You Will Learn In This Chapter

In this chapter you will learn about troubleshooting the following:

- Startup
- Ineffective cleaning
- Wash pump system
- Heating system
- Turntable drive
- Nozzles
- Foaming
- Power blast manifold (PBM)
- Solution-level control system
- Door limit switch
- Rinse system
- Automatic steam exhaust (ASE)
- Electrical control system

1. Startup

Use procedures in chapters *"Installation," "Advanced Operations: Process-Control,"* or *"Maintenance"* to correct a problem after you have diagnosed it.

Or, refer to your vendor-supplied manuals or cut sheets for instructions on correcting problems.

Problem: Washer will not start	
Check This:	**Probable Cause(s)**
APE pressure switch	Misadjusted Insufficient compressed-air supply
Clock override	Set to *OFF* (must be *ON*)
7-day clock	Not programmed; program 1 must be *ON*
Compressed-air supply	Shut-off Disconnected
Door	Not closed
Door limit switch	Trip-tab is not closing the switch (adjust) Door limit switch is interlocked with start circuit. To reset start circuit, washer door must be opened and closed so start circuit detects door limit switch contacts transfer indicating proper operation.

Fig. 6 - 1: Troubleshooting: Startup

2. Ineffective Cleaning

Use procedures in chapters *"Installation," "Advanced Operations: Process-Control,"* or *"Maintenance"* to correct a problem after you have diagnosed it.

Or, refer to your vendor-supplied manuals or cut sheets for instructions on correcting problems. Use procedures in chapters *"Installation," "Advanced Operations: Process-Control,"* or *"Maintenance"* to correct a problem after you have diagnosed it.

Or, refer to your vendor-supplied manuals or cut sheets for instructions on correcting problems.

Problem: Ineffective cleaning of parts	
Check This:	**Probable Cause(s)**
PBM	Linkage not connected
Turntable sprocket drive	Shafts not spinning (watch during wash cycle, or "jog")
Nozzles	Clogged
Pumps	Not operating (see *"Wash Pump System"* below)
	Unusual sounds (cavitation)
	Low amperage
Temperature	Incorrect for chemical being used
Chemical concentration	Incorrect (run a titration test)
Parts Position	Poor positioning of parts (re-position)

Fig. 6 - 2: Troubleshooting: Ineffective Cleaning of Parts

3. Wash Pump System

Use procedures in chapters *"Installation," "Advanced Operations: Process-Control,"* or *"Maintenance"* to correct a problem after you have diagnosed it.

Or, refer to your vendor-supplied manuals or cut sheets for instructions on correcting problems.

This section contains tables on the following problems:

- Wash pump motor won't start
- Wash pump surges
- Wash pump fails to deliver solution
- Wash pump motor trips overload -- high amperage reading
- Seal leakage at wash pump mounting plate
- Wash pump or motor vibrates or is noisy

Problem: Wash pump motor won't start	
Check This:	**Probable Cause(s)**
Power	Not *ON*
Starter	Overload tripped (reset it)
Voltage	Too low
Fuses	Not intact (remove and measure continuity)
Wires	Not tight enough
Wash timer	Not set to a value above “0”
Door limit switch	Not activating (door not closed)

Fig. 6 - 3: Troubleshooting: Wash Pump Motor Won't Start

Problem: Wash pump surges	
Check This:	**Probable Cause(s)**
Reservoir	Low solution level (check float assembly & solenoid)
Filter	Screen clogged

Fig. 6 - 4: Troubleshooting: Wash Pump Surges

Problem: Wash pump fails to deliver solution	
Check This:	**Probable Cause(s)**
Pump impeller	Partially clogged or loose
Pump suction	Partially clogged (clean suction filter)
Motor	Incorrect [counterclockwise] rotation
Reservoir	Low solution level (check float assembly & solenoid)
Nozzles	Clogged

Fig. 6 - 5: Troubleshooting: Wash Pump Fails to Deliver Solution

Problem: Wash pump motor trips overload -- high amperage reading	
Check This:	**Probable Cause(s)**
Pump or motor	Mechanical defects (rotate pump shaft by hand to verify if one of the following is causing the problem): Bent shaft Loose impeller Pump casing unbolted Throttle bushing failure
Solution	Too viscous (drain and replace) Chemical concentration too high Chemical has a high specific Chemical reaction with contaminates (jelling)
Nozzles	Missing or excessively worn (replace) Incorrect number of nozzles.
Manifold	Leaking (clean-out plugs are missing or loose)
Piping	Leaking high-pressure piping passing excess water. Loose pipefittings Union not tight Swivel leaking at packing gland. (tighten)
Voltage	Low Voltage or service capacity (amp capacity)

Fig. 6 - 6: Troubleshooting: Wash Pump Motor Trips Overload -- High Amperage Reading

Problem: Seal leakage at wash pump mounting plate	
Check This:	**Probable Cause(s)**
Pump	Mechanical defects: Throttle bushing failure
Shaft	Shaft-slinger failure

Fig. 6 - 7: Troubleshooting: Seal Leakage at Wash Pump Mounting Plate

Problem: Wash pump or motor vibrates or is noisy	
Check This:	**Probable Cause(s)**
Pump or motor	Bearings: Need lubrication Need to be replaced Damaged
Pump	Throttle bushing failure
Pump & motor	Coupling: Loose/dropped Wearing out
Pump	Impeller: Loose Damaged
Pump	Clogged -- restricts impeller
Pipes	Pipe strains - discharge piping improperly connected
Thrust bearing	Snap ring has worn a groove in the bearing frame & is spinning
Temperature too high	Pump cavitation

Fig. 6 - 8: Troubleshooting: Wash Pump or Motor Vibrates or Is Noisy

4. Heating System

Use procedures in chapters *"Installation," "Advanced Operations: Process-Control,"* or *"Maintenance"* to correct a problem after you have diagnosed it.

Or, refer to your vendor-supplied manuals or cut sheets for instructions on correcting problems.

This section contains tables on the following problems:

- Water does not heat (gas/oil burner does not ignite)
- Water does not heat (steam)
- Water does not heat (electric)

Problem: Water does not heat (gas/oil burner does not ignite)	
Check This:	**Probable Cause(s)**
Gas burner	Check for 120 volts at burner Check for gas at specified pressures Blower motor not running, Check for fan obstruction No ignition: (blower motor must be running) Flameproving rods Corroded (replace) Igniter rods Corroded (replace) Burner controller defective (replace) Poor combustion: Fuel/gas mixture Incorrect Main gas valve Defective Check for proper gas pressures Obstruction in flue. (clean out) Burner unit dirty. Clean Flue Damper Misadjusted
Hi-Limit	Hi-Limit tripped. Check for overtemp condition. Reset Hi-Limit controller. If problem continues contact MART Immediately.
Temperature controller	Not set high enough to call for heat. (Increase temp) Loose wires, (tighten). Thermocouple (sensor) not functioning. (Replace)
Reservoir	Low solution level (check float assembly & solenoid)
Float assembly	Not working (clean assembly)
7-day clock	Incorrect setting

Fig. 6 - 9: Troubleshooting: Water Does Not Heat (Gas/Oil Burner Does Not Ignite)

Problem: Water does not heat (steam)	
Check This:	**Probable Cause(s)**
Steam System	Steam solenoid not activated Steam source Steam not available from in-plant source Steam trap not operating -- may be clogged
Steam-heat exchanger, hole in exchanger -- steam escaping	
Temperature controller	Not set high enough to call for heat. (Increase temp) Loose wires, (tighten). Thermocouple (sensor) not functioning. (Replace)
Reservoir	Low solution level (check float assembly & solenoid)
Float assembly	Not working (clean assembly)
7-day clock	Incorrect setting

Fig. 6 - 10: Troubleshooting: Water Does Not Heat (Steam)

Problem: Water does not heat (electric)	
Check This:	**Probable Cause(s)**
Electric heaters	Defective element. (Replace) Defective wires, (loose, burned) Check for voltage Check for proper amperage Blown fuse. (Replace)
Temperature controller	Not set high enough to call for heat. (Increase temp) Loose wires, Tighten Thermocouple (sensor) not functioning. (Replace)
Reservoir	Low solution level (check float assembly & solenoid)
Float assembly	Not working (clean assembly)
7-day clock	Incorrect setting

Fig. 6 - 11: Troubleshooting: Water Does Not Heat (Electric)

Rapid ON/OFF Cycling of heat system:

This condition is caused by the temperature sensor probe being too close to the heat source. Position sensor probe tip to maintain a minimum of 4-6” from heat source.

5. Turntable Drive

Use procedures in chapters *"Installation," "Advanced Operations: Process-Control,"* or *"Maintenance"* to correct a problem after you have diagnosed it.

Or, refer to your vendor-supplied manuals or cut sheets for instructions on correcting problems.

This section contains tables on the following problems:

- Turntable does not rotate

Problem: Turntable does not rotate	
Check This:	**Probable Cause(s)**
Drive-gear motor	Not operating
Fuse/ overload	Blown/tripped
Slip clutch	Not operating -- slipping
Jack shaft	Not turning (not driven)
Sprocket	Not engaging table teeth (check with door open & "jog") Not lined up
Turntable	Not rotating freely: Defective bearings Loose bearings
Load on table	Shifted, and is causing imbalance
Securing devices	Caught on washer structure below table

Fig. 6 - 12: Troubleshooting: Turntable Does Not Rotate

6. Nozzles

Use procedures in chapters *"Installation," "Advanced Operations: Process-Control,"* or *"Maintenance"* to correct a problem after you have diagnosed it.

Or, refer to your vendor-supplied manuals or cut sheets for instructions on correcting problems.

This section contains tables on the following problems:

- Nozzles: ineffective cleaning

Problem: Nozzles -- Ineffective cleaning	
Check This:	**Probable Cause(s)**
Nozzles	Missing Worn out (check amperage draw) Not aligned with marks on PBM
Pump amperage	Nozzles worn out (amperage too high)
Manifold	Swivel is leaking Clean-out plugs are missing

Fig. 6 - 13: Troubleshooting: Nozzles -- Ineffective Cleaning

7. Foaming

Use procedures in chapters *"Installation," "Advanced Operations: Process-Control,"* or *"Maintenance"* to correct a problem after you have diagnosed it.

Or, refer to your vendor-supplied manuals or cut sheets for instructions on correcting problems.

Problem: Foaming	
Check This:	**Probable Cause(s)**
Operating temperature	Too low (raise temperature)
Chemical	Concentration: Wrong type of chemical Wrong concentration
Deferment	Not enough (add some to solution)
Oil skimmer removing defoamant (adjust skimmer timer to skim when solution is cooler)	

Fig. 6 - 14: Troubleshooting: Foaming

8. Power Blast Manifold (PBM)

Use procedures in chapters *"Installation," "Advanced Operations: Process-Control,"* or *"Maintenance"* to correct a problem after you have diagnosed it.

Or, refer to your vendor-supplied manuals or cut sheets for instructions on correcting problems.

This section contains tables on the following problems:

- PBM not oscillating

Problem: PBM not oscillating	
Check This:	**Probable Cause(s)**
Linkage	Not connected Out of adjustment Loose Not connected to shaft
Bearings	Failed
Swivel	Not properly adjusted Not lubricated Not moving freely
PBM gear motor	Not rotating (check wires/fuses/overload tripped)
PBM mounting plate	Motor not securely attached to it

Fig. 6 - 15: Troubleshooting: PBM Not Oscillating

9. Solution-Level Control System

Use procedures in chapters *"Installation," "Advanced Operations: Process-Control,"* or *"Maintenance"* to correct a problem after you have diagnosed it.

Or, refer to your vendor-supplied manuals or cut sheets for instructions on correcting problems.

This section contains tables on the following problems:

- Water not filling reservoir
- Water overflowing reservoir
- System not heating

Problem:	***Water not filling reservoir*** ***Water overflowing reservoir*** ***System not heating***
Check This:	**Probable Cause(s)**
Float rod	Binding
Limit switches	Not connected
	Dislocated
Torpedo cam	Slipped
Float	Dirty or jammed (clean)
	Missing ball
7-day clock	Incorrect setting
Clock override	Not *ON*

Fig. 6 - 16: Troubleshooting: Water Not Filling Reservoir, or Water Overflowing Reservoir, or System Not Heating

10. Door Limit Switch

Use procedures in chapters *"Installation," "Advanced Operations: Process-Control,"* or *"Maintenance"* to correct a problem after you have diagnosed it.

Or, refer to your vendor-supplied manuals or cut sheets for instructions on correcting problems.

This section contains tables on the following problems:

- Washer will not start

Problem: Washer will not start	
Check This:	**Probable Cause(s)**
Door limit switch (does not activate)	Door not closed Loose bolts (switch has slipped from mounting) Door tab not closing against switch (bend tab toward switch to make contact) Door limit switch is interlocked with start circuit. To reset start circuit, washer door must be opened and closed so start circuit detects door limit switch contacts transfer indicating proper operation.

Fig. 6 - 17: Troubleshooting: Washer Will Not Start

11. Rinse System

Use procedures in chapters *"Installation," "Advanced Operations: Process-Control,"* or *"Maintenance"* to correct a problem after you have diagnosed it.

Or, refer to your vendor-supplied manuals or cut sheets for instructions on correcting problems.

This section contains tables on the following problems:

- No rinse cycle

Problem: No rinse cycle	
Check This:	**Probable Cause(s)**
Rinse timer	Not set above "0"
Steam-exhaust fan	Not operating
Rinse solenoid	Not energizing
Power	Not *ON*
Float assembly	(see section *"Solution-Level Control System"*)
Wash-cycle timer	Cycle times too short to allow evaporation -- no makeup water needed (so no rinse cycle is possible)
Supply/Discharge hoses	Deteriorated Leaking
Nozzles	Clogged
Gauge reading	Water turned *OFF*
Regulator	Adjusted too low (adjust to higher pressure)

Fig. 6 - 18: Troubleshooting: No Rinse Cycle

12. Automatic Steam Exhaust (ASE)

Use procedures in chapters *"Installation," "Advanced Operations: Process-Control,"* or *"Maintenance"* to correct a problem after you have diagnosed it.

Or, refer to your vendor-supplied manuals or cut sheets for instructions on correcting problems.

This section contains tables on the following problems:

- ASE will not operate
- ASE leaks liquid

Problem: ASE will not operate	
Check This:	**Probable Cause(s)**
Wires	Not tight enough
Fuses	Blown
Blower fan	Wheel off shaft
	Corroded
ASE motor	Not operating - overload tripped
Piping	Clogged
	Collapsed
ASE timer	Not set above "0"

Fig. 6 - 19: Troubleshooting: ASE Will Not Operate

Problem: ASE leaks liquid	
Check This:	**Probable Cause(s)**
Flapper	Not letting steam exhaust
Piping	Clogged
Installation	Not done properly (re-read chapter *"Installation"*)
Motor	Too small for work environment/conditions
Rain cap	Missing (and required for your configuration)

Fig. 6 - 20: Troubleshooting: ASE Leaks Liquid

13. Electrical Control System

Use procedures in chapters *"Installation," "Advanced Operations: Process-Control,"* or *"Maintenance"* to correct a problem after you have diagnosed it.

Or, refer to your vendor-supplied manuals or cut sheets for instructions on correcting problems.

CAUTION! Always turn the main power supply OFF before working on the electrical control system.

NOTE: Use your electrical schematics to work on the electrical control system.

NOTE: If a part or assembly on the power washer will not work, check the "probable cause" electrical components given below.

Problem: Electrical control system

Check This:	Probable Cause(s)
Overload(s)	Need to be reset
Relay(s)	Need to be tightened or replaced
Fuse(s)	Need to be replaced
Timer(s)	Need to be tightened
	Need to be reset

Fig. 6 - 21: Troubleshooting: Electrical Control System

Also be sure to check:

- Facility fuses - If defective, replace
- Source voltage - If *OFF*, turn *ON*

7 Options

Purpose

This chapter contains information on any options you have that purchased from MART. The material in this chapter is meant to be used with material in other chapters -- for example, chapters *"Installation," "Operations,"* and *"Maintenance."*

Prerequisites

Before you read this chapter, we recommend that you read the following thoroughly:

- *"Important Safety Instructions and Warnings"* (in the front material)
- Chapter 1, *"Overview"*

Safety/Precautions

Before you install, operate, or maintain any option, read and follow these recommended safety/precaution instructions:

WARNING! NEVER get inside the washer cabinet when the main power supply is ON. This could result in severe injury or death.

WARNING! Be sure that people who install and maintain the washer and options are qualified and trained for the task.

What You Will Learn In This Chapter

In this chapter you will learn the following about each option:

- Theory of operation
- Installation
- Operations
- Maintenance
- Troubleshooting

1. Automatic Turntable/Swivel Bearings Lubrication

The automatic turntable and swivel bearings lubrication system helps ensure that these critical bearings are lubricated every set number of wash cycles.

1.1. Theory of Operation

The automatic lubrication system consists of the following: (refer to the following figure)

- Grease reservoir
- Pneumatically driven grease pump
- Grease dividing valve
- Pneumatic control valve
- Filter, regulator, lubricator
- Control Panel

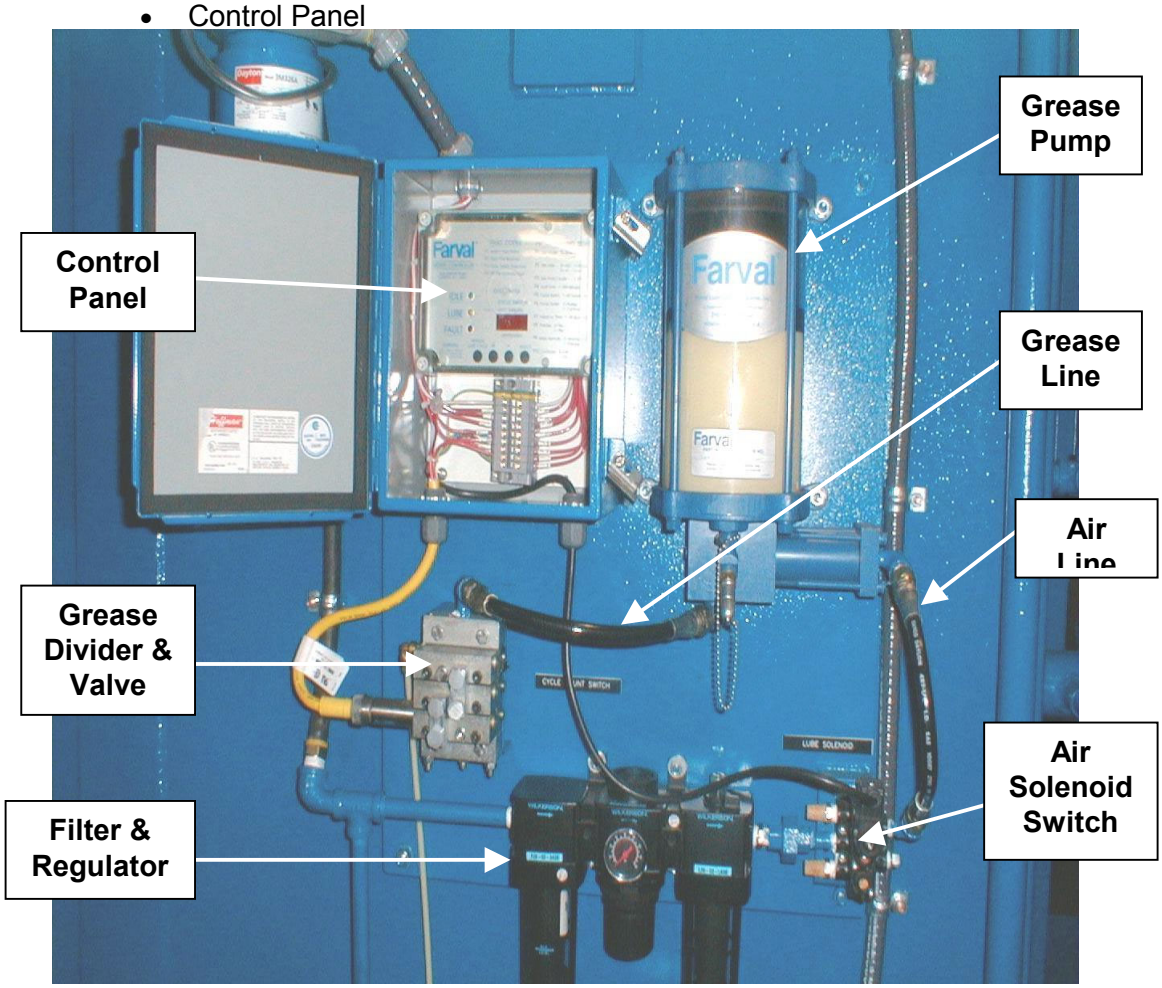


Fig. 7 - 1: Automatic Lubrication System Block Diagram

The air solenoid valve repeatedly cycles open and closed for a timed duration. Each opening and closing of the solenoid valve causes the grease pump to make one stroke. The grease is pumped from the reservoir to the grease-dividing valve. The dividing valve proportions the proper amount of grease flow from the pump to each bearing. Grease lines carry the grease flow from the dividing valve to each of the lubrication points:

- Turntable upper and lower bearings
- PBM swivel bearings

An electronic programmable controller inside the control panel mounted next to the grease pump controls the automatic lubrication system. A counter in the controller counts washer cleaning cycles and initiates a lubrication cycle after a preset number of cleaning cycles. (The factory pre-set is 1 cycle, which means that the automatic lubrication system will start every wash load.)

The duration of the lubrication cycle (which controls the number of cycles of the dividing valve and, therefore, the amount of grease pumped during a lubrication cycle) is programmable in the controller. The factory preset is for 5 cycles.

1.2. Installation

The automatic lubrication system arrives factory-installed.

1.3. Operations

Lubrication system operations are performed automatically. They may also be started manually.

The controller is programmed at the factory for an auto-lube cycle every machine wash cycle. The duration of the auto-lube cycle is factory preset for 5 cycles. These settings are initial startup settings only. You may want to change them depending on your needs.

The complete controller program with the factory presets is as follows:

Program Step	Setting	Description
Step #1	1	= Machine Counts
Step #2	0	= Counts X 1 - Each machine cycle counts 1
Step #3	1	= Run lube after every machine cycle
Step #4	1	= Number of minutes before “fault” occurs during lube
Step #5	5	= Number of switch transitions of cycle switch during lube cycle
Step #6	0	= Pulsed output to pump solenoid valve
Step #7	3	= Seconds of power on time for pulsed output
Step #8	0	= Idle mode, no lube on power up.
Step #9	1	= Normally energized fault relay, goes off during power loss.
Step #10	1	= Places controller in the operating mode

These settings set the controller for machine cycle mode. For further information on changing program settings and on the controller, refer to the supplied vendor information on the controller.

To adjust the number of wash cycles before an automatic lubrication cycle, or to change the duration of the lubrication cycle, read the vendor-supplied controller manual and adjust the controller steps as follows:

- Adjust Step # 3 to change the number of machine cycles required to initiate an automatic lubrication cycle.
- Adjust Step #4 to 1.3 times the lube cycle duration. (This depends on your setting for Step #5; determine the amount of time Step #5 requires, then adjust Step #4. *For example*, if the lube (Step #5) takes 10 minutes, set Step #4 to 13 minutes.)
- Adjust Step #5 to change the amount of grease pumped per automatic lubrication cycle.

NOTE: Step #3, Step #4 and Step # 5 are the only program changes that should ever be made in the field.

NOTE: Bearing Lubrication

Bearing lubrication is critical: Before making *any* changes to the lubrication cycle, refer to chapter "*Advanced Operations: Process-Control"* and to chapter *"Maintenance"* for information on required lubrication.

NOTE: *Use Lubriplate 1444 grease ONLY.*

Bearings are receiving too much grease: Adjust the lubrication duration. Adjust the Lube Cycle Counter to a higher number of cycles. See the *Operations* section for instructions on changing the controller program.

Bearings are receiving too little grease: Lengthen the lubrication duration. Set the Lube Cycle Counter to 1 so that a lubrication cycle is run every washer cleaning cycle. Check the system for proper operation. See the *Operations* section for instructions on changing the controller program.

Automatic Operation:

The control panel has an *off-auto* switch for controlling power to the auto-lube system. To run the system turn the switch to *auto*. The auto-lube system will function automatically until this switch is turned off.

Manual Operation:

To run the lubrication system at times other than those programmed, open the control panel door for the auto-lube system and press the *manual* button on the controller. The auto-lube system will start an (automatic) lubrication cycle.

Indicator Lights:

There are two indicator lights on the control panel. The *Lubrication Cycle* light will flash during the auto-lube cycle. The *Lubrication Fault* light will light should the controller detect a fault during an auto-lube cycle.

1.4. Maintenance

Every 8 hours of operation:

- Check the grease reservoir fill-level. Refill as required, according to the grease pump/reservoir manufacturer's instructions.
- Check the Auto-lube control panel for a fault indication. If the fault indicator is *ON*, your Auto-lube system is not providing grease to the bearings. Discontinue washer operations until the problem is corrected. Refer to section *Troubleshooting*.

NOTE: *Use Lubriplate 1444 grease ONLY.*

Every 160 hours of operation:

- Check the filter/regulator/lubricator unit. The lubricator has an oil reservoir, and is located on the right side of the washer. Add oil, if required, to the fill-level.

Refer to your vendor-supplied cutsheet for instructions.

NOTE: If the system runs out of grease, you will have to prime the system.

1.5. Troubleshooting

This section contains tables on the following problems:

- Automatic lubrication system fault light is *ON*

Problem: Automatic lubrication system fault light is ON	
Check This:	**Probable Cause(s)**
Grease Pump	Empty (refill grease reservoir)
Control valve	Stuck (replace)
Air-pressure	Not in the 75-100 PSI [1000-1400 kg/sq cm] range (check air-supply system)
Electric solenoid	Burned out (replace)
Grease dividing valve	Air bubble bled all air out of the system Stuck (disassemble, clean, & bleed)
Power	Verify that the controller has power
Step #4 in controller program	Time set too short

Fig. 7 - 2: Troubleshooting: Automatic Lubrication System Fault Light Is *ON*

NOTE: Bearing Lubrication

<u>*Bearing lubrication is critical*</u>: Before making *any* changes to the lubrication cycle, refer to chapter "*Advanced Operations: Process-Control"* and to chapter *"Maintenance" for* information on required lubrication.

NOTE: *Use Lubriplate 1444 grease ONLY*.

Bearings are receiving too much grease: Adjust the lubrication duration. Adjust the Lube Cycle Counter to a higher number of cycles. See the *Operations* section for instructions on changing the controller program.

Bearings are receiving too little grease: Lengthen the lubrication duration. Set the Lube Cycle Counter to 1 so that a lubrication cycle is run every washer cleaning cycle. Check the system for proper operation. See the *Operations* section for instructions on changing the controller program.

2. Clean Machine

The Clean Machine reduces clean out and re-charging of the cabinet reservoir. It automatically separates and collects sludge, metal particles, tramp oils, and other contaminants during the wash cycle.

2.1 Theory of Operation

The Clean Machine can be set to operate manually or on a timer, and can operate whether or not the washer is in operation. When the Clean Machine is in operation, washer solution is pumped from the washer reservoir through the Clean Machine and back into the reservoir. Eductors connected to the return line churn the reservoir solution to prevent sludge from settling and building up.

Two processes are used in the Clean Machine to separate oils, greases, and particulate matter from the cleaning solution:

- A *hydrocyclone* removes heavy particles and entrains air into the solution. Heavy particles settle out in a sludge-collection bin, from which the sludge must be periodically removed.

- Solution then flows into a chamber, where the entrained air brings oils and greases to the surface by coalescing action. A powered, rotating *skimmer* removes the oils and greases that collect on the solution surface. A *scraper* removes the collected material from the skimmer and deposits it in a collection device for further treatment, processing, or disposal.

The Clean Machine segregates the waste streams generated by washing, allowing you to:

- Collect waste oils and greases easily, and recycle them off-site
- Dispose properly of particulate matter

2.2 Installation

Install the power washer as described in chapter *"Installation."* When you charge the power washer with chemical, remember to add enough chemical to take into account the 135 gallons (511 liters) of solution that will fill the Clean Machine's separator tank.

Clean Machine
Physical Dimensions and Capacity

Length	5 feet, 3 inches	(1.60 m)
Width	2 feet, 3 inches	(.69 m)
Height	6 feet, 2 inches	(1.88 m)
Capacity	135 gallons	(511 liters)

Follow this procedure:

1. Set the *separator tank* by the *right side* of the *washer*. Leave enough room for access to the burner/heating elements, and opening the cabinet door. Be sure that when it is fully open, the door will not touch the Clean Machine.

2. Level the separator tank, if necessary. Refer to chapter *"Installation -- Leveling."*

3. Anchor the separator, using 5/8-18 bolts through the welded nuts on the feet of the tank. Refer to chapter *"Installation -- Anchoring."*

4. Refer to the following figure to install *piping* between the washer and the Clean Machine.

NOTE: Use schedule 40 black iron pipe, stainless-steel flex hose, or any other material suitable for 50% sodium hydroxide at 200° F. (93° C). All connections must be leakproof.

- *Install line #1*: 1 1/2-inch-diameter pipe from the 2-inch-diameter ball valve to the cyclone inlet.

- *Install line #2*: 2-inch-diameter pipe from the 2-inch-diameter coupling at the Clean Machine sludge tank to the 2-inch-diameter coupling at the right rear of the washer.

- *Install line #3*: 3-inch-diameter pipe from the 3-inch-diameter coupling on the Clean Machine tank to the 3-inch-diameter coupling at the right rear of the washer.

NOTE: Return pipelines to the power washer are gravity feed and must run downhill.

NOTE: Use a minimum of elbows and bends in the piping configuration. Refer to chapter *"Installation"* for more information.

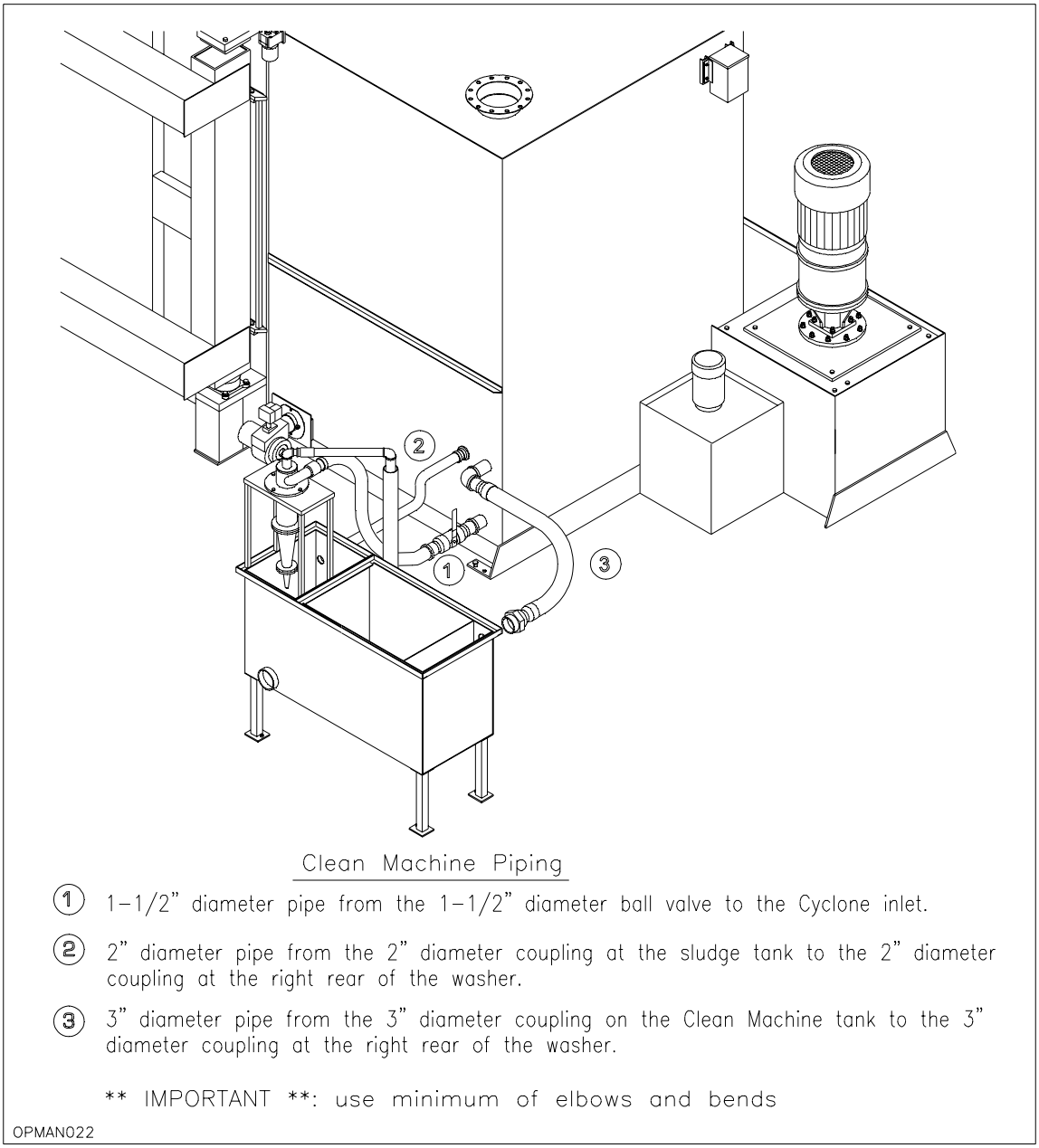


Fig. 7 - 3: Clean Machine Piping

5. Install the *wiring* between the Clean Machine and the washer as follows:

    - Run the sealtite *conduit*, located at the back of the *washer*, near the pump, to the *control box* on the *Clean Machine.*

    - Hook up the *conduit* to the *box* through the bottom of the box.

    - Install the *6 wires* to the *electrical box* as follows:
      Red Wire----------#10
      Green Wire----------Ground
      Pink Wire ----------SK
      White Wire ----------Neutral
      Black Wire----------Contactor
      Black Wire----------Contactor

6. Place an approved *container* at the *outlet* of the *skimmer assembly* to collect waste and tramp oils.

WARNING! Fill the Clean Machine's separator tank BEFORE you turn on the heat!

7. Set the *temperature controller* (aquastat), located on the side of the Clean Machine's separator tank, to 170° F (77° C). The heater replaces heat lost when the solution is in the tank -- it is NOT designed to heat solution from ambient temperature.

NOTE: Leave the heating loop *ON* for the Clean Machine's separator tank even when the washer is not in operation.

8. Verify that part of the *Clean Machine's pump flow* is directed to the washer (to agitate the solution and keep contaminates in suspension).

9. Verify that the *remainder of pump output* is directed to the Clean Machine's *separator tank*.

2.3 Operations

The Clean Machine system is designed to operate when the washer is in use, *or* after hours, when the washer is in "shut-down" (*off*) mode.

> NOTE: The maximum separation of sludge and oils will occur after a few days of washing heavily soiled parts.

To operate the Clean Machine, *follow this procedure*:

1. Set the Clean Machine's *selector switch*, located on the washer's control panel, to one of the following:

    - *Manual:* Activates the Clean Machine's pump. It will run continuously.
    - *Off:* Turns the Clean Machine's pump off.
    - *Auto:* Automatically activates and runs the Clean Machine according to the program set for circuit #2 of the 7-day clock.

    > **NOTE**: You *must* program the 7-day clock's circuit #2 for *ON/OFF* times, and set the Clean Machine's selector switch to *auto.*

2. After you activate the Clean Machine, verify the following:

    - The oil skimmer is rotating clockwise.
    - Water is being discharged from the bottom of the hydrocyclone.

> **NOTE**: To adjust the control valve on the Clean Machine pump, open the valve *completely*. Then, if you notice that water overflows from the oil skimmer tank into the sludge tank, slowly close the 1 1/2-inch-diameter (3.8 cm) valve just until water no longer overflows. Open the gauge valve on the cyclone, and note the pressure reading. The reading should be more than 15 PSI for the best separation. Close the gauge valve to protect the gauge.

2.3.1 Clean-Machine Operation: Frequency

The amount of contaminants on the parts to be washed will determine how often you should operate the Clean Machine.

Recommendations:

Heavy Soils Operate the Clean Machine on a daily, continuous basis.

Light Soils Operate the Clean Machine every other day.

> **NOTE**: If sludge builds up on the front floor of the washer reservoir, operate the Clean Machine more often.

2.3.2 Clean Machine: Chemical Management

Use the same chemical-management principles for the Clean Machine that you use for the power washer.

Refer to section *"Chemical-concentration Management"* in chapter *"Advanced Operations: Process-Control."*

2.4 Maintenance

Sludge removal is the principal maintenance required on the Clean Machine.

> **NOTE**: You do *not* have to drain the washer or the oil-skimming tank to remove accumulated sludge in the Clean Machine's sludge holding tank.

The hydrocyclone removes contaminates larger than 50 microns (table salt is approximately 100 microns in diameter). The exact rating is dependent on a number of factors, including the specific gravity of the particle, the actual particle size, and the pressure at the cyclone entrance.

The hydrocyclone expels sludge from its apex into the sludge chamber underneath. Because the hydrocyclone also discharges some water during operation, the sludge holding tank initially fills with water, up to the return outlet.

As operation continues, sludge that is removed from the washer displaces water in the sludge holding tank. Clean out the sludge when it reaches the bottom of the water return outlet.

Follow this procedure:

1. Place an approved *container* under the *5-inch (13 cm) cap*.
2. Remove the *cap* from the *sludge holding tank*.
3. Push *sludge* out through the *opening* into the *container*.
4. Replace and tighten the *cap*.

2.5 Troubleshooting

CAUTION! Never run the oil skimmer in a tank where there is no oil on the solution surface. The absence of oil creates excess drag on the skimmer motor. This will damage the motor.

This section contains tables on the following problems:

- Clean machine does not heat
- Hydrocyclone does not separate
- Oil skimmer tank overflows into cyclone separator tank
- Skimmer-wheel drain trough backs up

Problem: Clean machine does not heat

Check This:	Probable Cause(s)
Aquastat	Incorrect temperature (set controller to 170°F [77°C])
Amperage	Low draw: Wires may be loose Heating element may need to be replaced
Fuses	Blown (power *OFF*, then pull out of electrical box to check)

Fig. 7 - 4: Troubleshooting: Clean Machine Does Not Heat

Problem: Hydrocyclone does not separate

Check This:	Probable Cause(s)
Ball valve	Ball valve on the discharge line from the pump needs adjustment
Cyclonic separator	Clogged (remove bottom clamp & clean out debris)
Pressure at cyclone	Too low (15 PSI minimum)

Fig. 7 - 5: Troubleshooting: Hydrocyclone Does Not Achieve Cone Effect

Problem: Oil skimmer tank overflows into cyclone separator tank	
Check This:	**Probable Cause(s)**
Discharge line	Clogged overflow pipe
Ball valve setting	Improper adjustment (adjust)

Fig. 7 - 6: Troubleshooting: Oil Skimmer Tank Overflows into Cyclone Separator Tank

Problem: Skimmer-wheel drain trough backs up	
Check This:	**Probable Cause(s)**
Drain trough	Clogged
Blades	Not contacting wheel: Bend to adjust Replace if worn
Wheel	Not turning (check/tighten shaft nuts)
Motor	Motor not turning (115 V): Fuse needs to be replaced Wires need to be tightened Motor needs to be replaced

Fig. 7 - 7: Troubleshooting: Skimmer-Wheel Drain Trough Backs Up

3. Center Manifold

The optional center manifold is used to clean very narrow-diameter, hollow, long parts whose interior is inaccessible to the washing solution. Examples of such parts include gun barrels, long pipes, and turbine pumps.

The center manifold oscillates vertically inside the part as the part rotates in the center of the turntable. The center manifold cleans the interior as the power blast manifold (PBM) cleans the exterior.

3.1. Theory of Operation

A *superstructure* on the reinforced roof of the washer cabinet houses the *center manifold*, as shown in the following figure. The center manifold consists of a vertical manifold tube the length of the work height of the washer, with 2 wash nozzles located horizontally and connected to the lower end. The tube is guided through a pair of bushings in the cabinet roof. The tube is raised and lowered by a roller chain and carriage, which are driven by a gear motor.

Wash solution is piped to the vertical manifold tube through a hose attached to the back of the cabinet roof. Optionally, an extra tube may be attached to the vertical manifold tube for carrying rinse water to a pair of rinse nozzles on the lower end of the manifold. Flexible tubing is connected to the hose to carry rinse water. The fluid flow for the center manifold is provided from a tap off the flow to the power blast manifold (PBM).

Door Lock. The center manifold system incorporates an additional feature on the standard washer to help prevent accidental damage to the vertical manifold tube or parts on the turntable. An electrically actuated solenoid locks the washer cabinet door closed during operating cycles to prevent accidental opening with the center manifold in the down position. The door remains locked until the manifold returns to the *home* position. The lock functions automatically whenever the center manifold system is used (in manual *and* automatic modes).

Power is required to unlock the door. In the event of a power failure, or if power is turned off to the machine, the door-lock solenoid will de-energize and lock the door. The lock can be manually by-passed by pushing up the small pin that protrudes below the solenoid lock box and opening the door. This will probably require the assistance of another person. Be sure the manifold is in the *home* position before performing this procedure.

3.2. Installation

This option arrives with the vertical manifold and superstructure disconnected.

To install the center manifold, *follow this procedure*: (refer to the following figure)

1. Place beads of sealant around the roof opening.
2. Place the superstructure (frame and mechanism) on the pad support on the roof.
3. Connect the superstructure plate to the pad on the roof.
4. Connect the wash and rinse lines to the connections on the roof.
5. Connect bracing, if supplied.
6. Connect wires to the gear motor and to the brake assembly to the limit switch.

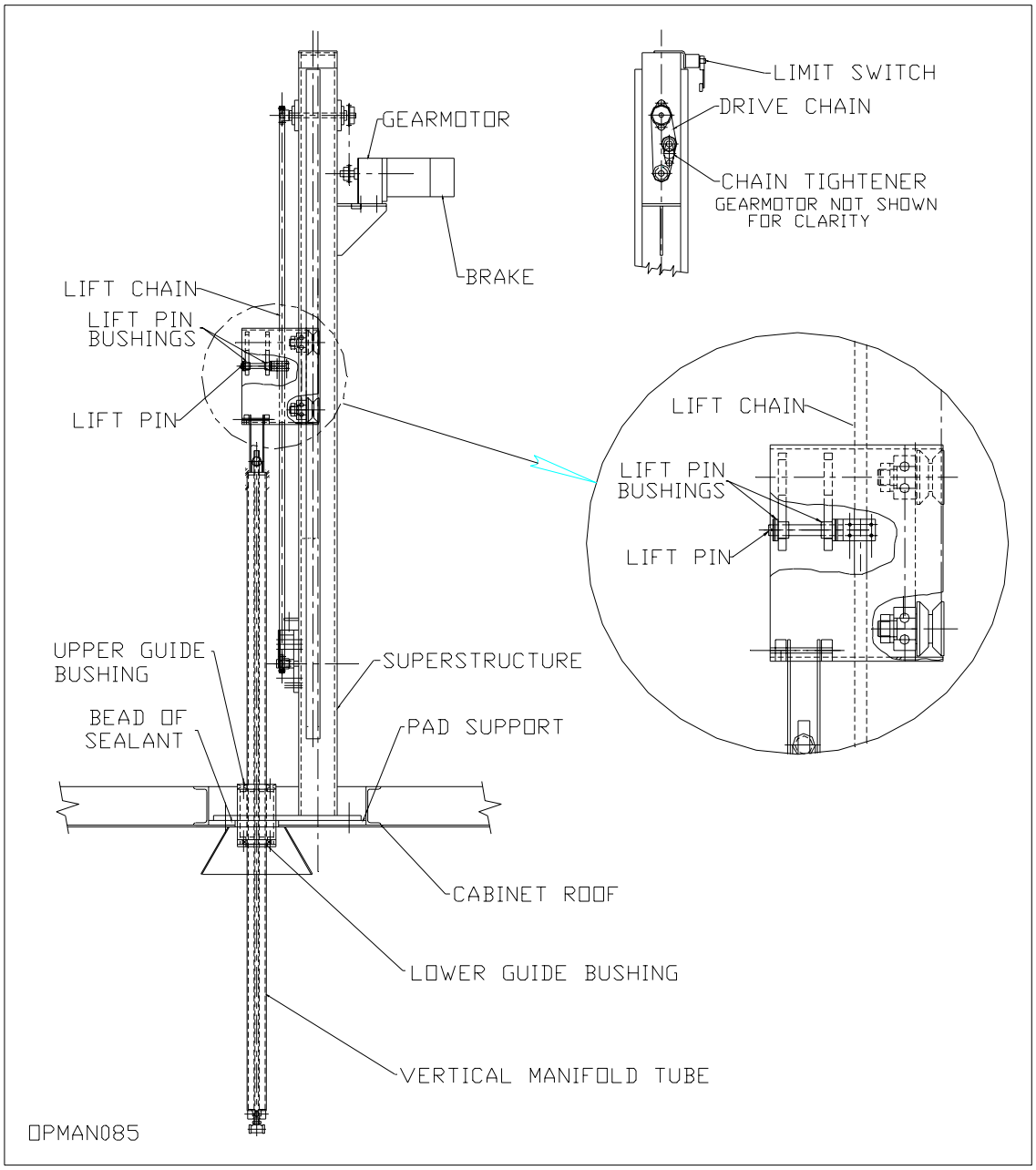


Fig. 7 - 8: Center Manifold Mechanism and Superstructure

3.3. Operations

WARNING! The <u>minimum inside diameter</u> of a part that can be cleaned by the center manifold is 5 inches.

To operate the center manifold, *<u>follow this procedure</u>*:

1. Verify that the manifold is *up* near the roof of the cabinet.

   The center manifold has an automatic *Home* (or *up*) position controlled by a limit switch at the top of the superstructure.

2. Place the part to be washed in the center of the turntable. (A special fixture may be needed to keep the part centered on the turntable and properly aligned with the center manifold.)

   WARNING! Be sure the part is centered properly, so that the center manifold does not hit the part!

3. Set the ***center manifold mode*** *selector switch*, located on the washer's control panel, to one of the following:

   - *Man:* Turns *<u>auto</u>* mode *<u>OFF</u>*. Activates the ***manifold jog*** *push button,* which lets you manually control the down/up position of the center manifold.
   - *Auto:* Returns the manifold to the *home* position, and sets *automatic cycle* as part of the wash/rinse cycle. A light on the control panel illuminates each time the center manifold strokes during operation. The center manifold works with the power blast manifold (PBM).
   - *OFF:* Returns the manifold to the *home* position, and disables *auto* cycle.

Refer to chapter *"Basic Operations"* for more information on loading and unloading parts.

3.4. Maintenance

Refer to the previous figure to help locate parts during maintenance procedures.

Every 40 Hours of Operation

Oil the chains and lift-pin bushings in the carriage.

Follow this procedure:

1. Turn the *main power supply OFF*.
2. Verify that the manifold is up near the top of the cabinet roof, in the *Home* position.
3. Inspect the lift chain; lift pin, and bushings for wear and looseness.
4. *If loose,* tighten the lift chain by using the adjuster located near the bottom of the superstructure.
5. Check the adjustment of the drive chain at the gear motor. Remove any excess play with the chain tightener.

Every 250 Hours of Operation

Teflon Bearing Plates

Inspect the Teflon bearing plates in the double-bearing housing. Look for excessive sideways movement of the center manifold or for bearing wear (hole is oblong): Replace the plates.

3.5. Troubleshooting

This section contains tables on the following problems:

- Water leaks onto cabinet roof
- Center manifold assembly does not work
- Center manifold light does not illuminate

Problem: Water leaks onto cabinet roof	
Check This:	**Probable Cause(s)**
Manifold hose	Cracked (replace) Loose (tighten)
Rinse pipefittings	Broken tubing (replace) Loose fittings (tighten)

Fig. 7 - 9: Troubleshooting: Water Leaks Onto Cabinet Roof

Problem: Center manifold assembly does not work	
Check This:	**Probable Cause(s)**
Superstructure	Damaged
Limit switch	Damaged (replace)
Electric solenoid	Burned out (replace)
Fuses	Blown (turn power *OFF* and pull out of electrical control panel to check)
Relay(s)	Need to be tightened or replaced
Overload	Tripped (reset) Chain jammed Brake not releasing

Fig. 7 - 10: Troubleshooting: Center Manifold Assembly Does Not Work

Problem: Center manifold light does not illuminate	
Check This:	**Probable Cause(s)**
Selector switch	Not set to *auto* or *manual* (manifold at *home* position)
Switch light bulb	Burned out (replace)

Fig. 7 - 11: Troubleshooting: Center Manifold Light Does Not Illuminate

4. Chemical Conductivity Controller

After you have determined an effective chemical concentration, as described in chapters *"Overview"* and *"Advanced Operations: Process-Control,"* you must monitor and maintain that concentration to provide consistent cleaning performance.

The optional Chemical Conductivity Controller automatically monitors and maintains chemical concentration by electronically measuring the (electrolytic) conductivity of the cleaning solution. This is a useful technique for figuring out when to add more detergent to a high-ionic strength cleaning solution such as those based on salts. (Potassium hydroxide, sodium hydroxide, or sodium metasilicate) This is **not** a useful technique for monitoring high emulsifying cleaners that rely on surfactants for a significant part of the cleaning mechanism.

Electrolytes are ionic compounds such as salts, acids, or bases. Added to water, or a water-based (aqueous) solution, they increase its conductivity.

Conductivity is defined as the ability of a substance to conduct electric current. All aqueous solutions conduct electricity to some degree. The addition of electrolytes increases conductivity. Since conductive liquids consist of ionic compounds (electrolytes) dissolved in water, more ions in the solution indicate higher conductivity. In applications using very pure to very concentrated chemical solutions, a rising conductivity reading indicates a generally increasing chemical concentration.

Thus, a simple electronic conductivity test can measure the makeup of a ionic solution and indicate its approximate chemical concentration. Unfortunately, compounds other than cleaning chemicals affect the conductivity of the solution (These compounds include iron oxide (rust) and carbon, both commonly found in most washing applications.) And some cleaning compounds are not conductive. Conductivity measuring systems provide an *estimate* of the strength of the chemical in the solution by measuring the *relative* conductivity of the solution.

Conductivity is expressed in millionths of a Siemen: microSiemens/cm, or μS/cm. One mS/cm equals 1000 μS/cm.

Contact your chemical supplier for a chart of conductivity vs. concentration for your chemical and to determine if conductivity measurement is an appropriate technique for controlling the concentration of your solution.

4.1. Theory of Operation

The Chemical Conductivity Controller system consists of the following:

- Conductivity controller
- Electrode-probe
- Peristaltic pump
- Tubing

For the system to function properly, the concentration of your chemical must be proportional to its conductivity.

The system measures conductivity with electronics connected to a *probe* immersed in the washer's cleaning solution. A concentrated chemical is added by a pump to maintain the conductivity of the solution at the selected set point.

The *conductivity controller* uses a set point for the minimum allowable conductivity. When the electrode probe senses that **conductivity has fallen below the set point** you have selected, it closes a relay. If the relay closes while the wash pump is operating, the *peristaltic pump* activates and pumps concentrated chemical solution into the washer's reservoir. Concentrate is only added during the wash cycle, so that mixing occurs. When the probe senses that **conductivity has risen above the set point**, the controller relay opens. This prevents the peristaltic pump from adding concentrate.

The peristaltic pump turns rollers, which squeeze concentrate through the precision-bore, high-tolerance tubing in a wave-like motion, acting like a positive-displacement pump. The concentrate comes in contact *only* with the tubing, *not* the pump. The pump is self-priming and non-siphoning.

The probe is mounted to the end of a tube. This tube is used to insert the probe into the pump suction tube. The probe can be removed without draining the washer.

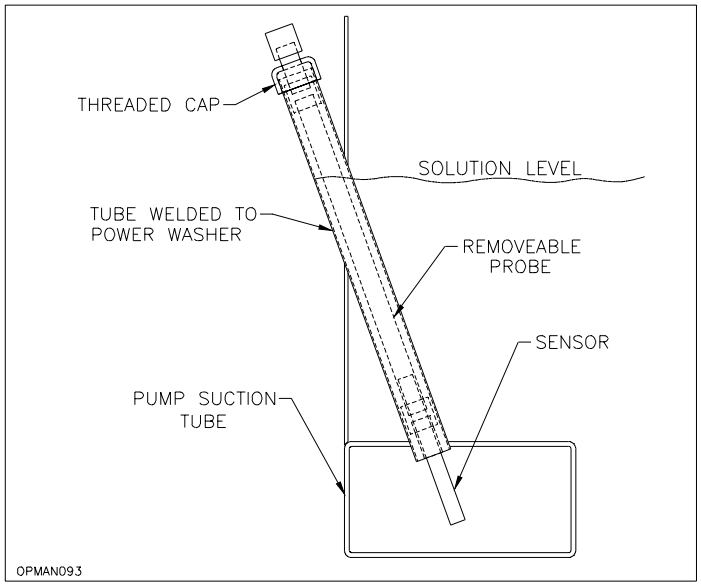


Fig. 7 - 12: Chemical Conductivity Probe

Chemical Management

When a washer is first put into service, it is easy to compute the concentration of the cleaning compound, because you started with a fixed volume of water and added a known quantity of chemical. After you begin using the washer, however, you can only *estimate* the chemical concentration -- until you drain the washer, clean it out, and recharge it with fresh water and chemical.

There are two commonly used estimating tools:

- Conductivity measuring systems
- Titration kits

Conductivity Measurement

A conductivity measuring system measures the strength of a fixed electrical current flowing between two or more electrodes that are held at a fixed distance. Since the addition of cleaning compounds (chemical) to water changes the capacity of water to conduct electricity, conductivity measuring systems can provide an *estimate* of the strength of the chemical in the solution by measuring the *relative* conductivity of the solution.

Unfortunately, compounds other than cleaning chemicals also affect the conductivity of the solution in the washer. These compounds include iron oxide (rust) and carbon, both commonly found in most washing applications.

This means that while conductivity measuring systems can be used as a control point, this is done with the understanding that the oils, greases, metal particles and other contaminants that are byproducts of the cleaning process affect conductivity.

Thus, the only true measure of chemical concentration is to use titration tests in conjunction with conductivity measurements to determine a correlation. Once you know the correlation, you can get a fairly accurate estimate of chemical concentration in the solution by using a conductivity measuring system.

Titration

Titration is the estimation of the strength of a compound by measuring the amount of another compound of known strength that is required to produce an observable reaction.

Almost all titration kits supplied with cleaning compounds use phenolphthalein (indicator P) as a reactant, and an acid (hydrochloric or phosphoric) as a neutralizer. The indicator P turns red or pink or blue when added to a sample of the solution. By counting the drops of acid it takes to turn the solution back to its original color, you can arrive at a good *estimate* of the chemical concentration.

Correlating Titration Results and Conductivity Measurements

To measure the chemical concentration in your washer's cleaning solution, titrate the solution once a week and perform a conductivity test at the same time. Your objective is to learn how chemical concentration and conductivity vary from wash to wash. Set up a graph that shows the correct concentration, and then graph the actual variance in concentration and conductivity.

After several weeks of testing and graphing, you should see a pattern -- this is the correlation between chemical concentration and conductivity. Given any conductivity reading on your graph, you will most likely see a difference between the ideal and the actual chemical concentration of the solution. Use this "compensation factor" to know how to adjust chemical concentration based on conductivity readings.

Conclusion

After you have developed a correlation between chemical concentration (the results of titration) and conductivity measurement testing, you can use a conductivity measuring system to provide a *close estimate* of the strength of the chemical in the solution.

At this point, conductivity measurement can be used for one of two purposes:

- As an indicator of the need to titrate.
- As an indicator of the need to add chemicals.

If the correlation between conductivity and titrated concentration is close enough for the purposes of the operator, then titration should only be used as a periodic check on the conductivity measuring system.

4.2. Installation

The Chemical Conductivity Controller system is factory-installed and shipped ready for use.

The electrode-probe arrives installed in the washer, based on your specifications.

4.3. Operations

Follow this procedure:

1. Check the *conductivity reading* on the *controller panel* at the chemical concentration recommended by your chemical supplier, or developed through process-control testing (refer to chapter *"Advanced Operations: Process-Control."*)

2. Adjust the *LO set point* to this reading.

> **NOTE**: Refer to the controller-vendor-supplied manual for instructions on changing ranges and setting set points.

3. Insert the *peristaltic pump suction tube* into a *barrel* of 50%-diluted chemical concentrate.

> **NOTE:** The peristaltic pump only pumps during wash cycles when chemical is needed.

4.4. Maintenance

Every 160 hours of operation:

- *Monitor* chemical usage by the peristaltic pump. Replace the empty barrel after the concentrate has been completely used.
- *Test* peristaltic pump operation:
    1. Set the controller *LO set point* 10% below the actual solution conductivity.
    2. Run a wash cycle.
    3. Verify that the pump is pumping chemical into the reservoir.
    4. Re-set the LO set point to your *control set point*.

Peristaltic Pump and Tubing

The pump has few moving parts, and no seals or valves to clog, clean, or replace. As tubing fatigues (and eventually cracks), move it to a section that has not been under the pump rollers. Then, continue pumping.

When you run low on tubing, order a new spool.

Sludge Clean-Out

During sludge clean out, clean the probe thoroughly. Follow the vendor-supplied instructions.

4.5. Troubleshooting

This section contains tables on the following problems:

- Peristaltic pump does not pump
- Concentration cannot be maintained

Problem: Peristaltic pump does not pump	
Check This:	**Probable Cause(s)**
Pump tubing	Cracked (move or replace)
Barrel	Empty of concentrate (replace)
Power	Not *ON*
Fuses	Not intact (remove and measure continuity)
Overloads	Not all of them are re-set
Probe	Dirty (clean)
Set point	Too high (set below readout level)
Pump motor	Defective (replace)

Fig. 7 - 13: Troubleshooting: Peristaltic Pump Does Not Pump

Problem: Conductivity cannot be maintained	
Check This:	**Probable Cause(s)**
Peristaltic pump tubing	Cracked (move or replace)
Barrel	Empty of concentrate (replace)
Conductivity controller	Set point incorrectly set
	Defective
Chemical	Concentration: Wrong type of chemical Wrong concentration recommended or developed Concentration not proportional to conductivity

Fig. 7 - 14: Troubleshooting: Conductivity Cannot Be Maintained

5. Internal Reservoir Cover

The internal reservoir cover provides the following benefits:

- Safety: Provides a barrier covering the wash solution reservoir. This isolates the operator from accidental contact with the hot wash solution as might occur if someone was to slip and fall.

- Catch: Catches small parts that may loosen during the cleaning cycle and fall from the turntable. The floor prevents the parts from falling into the solution and being lost in the reservoir.

- Insulation: Provides a thermal insulation cover over the reservoir tank. This slows down the heat loss from the reservoir (saves energy) especially when the cabinet door is open.

5.1. Theory of Operation

The internal reservoir cover is steel-sheet-supported by angles welded to the cabinet walls above the wash solution reservoir and below the turntable. It funnels all liquid back through an expanded-metal screen area to the reservoir.

The internal reservoir cover is removable for sludge clean out and other maintenance procedures. It is held in place by thumbscrews, which are easily removed and replaced.

5.2. Installation

If you purchase the optional internal reservoir cover, your power washer is delivered with the internal reservoir cover factory-installed and ready to use.

5.3. Operations

There are no operational procedures for the internal reservoir cover.

WARNING! Do NOT OVERLOAD the internal reservoir cover or other horizontal surfaces. The internal reservoir cover is intended as a chemical-solution cover ONLY! Horizontal surfaces are NOT designed for walking or standing! Walking on the internal reservoir cover, tank cover, or other horizontal surfaces could result in serious injury or death.

5.4. Maintenance

Clean the internal reservoir cover as required. Pay particular attention to the expanded-metal screen area: be sure that no bolts or other parts, gasket material, or debris clog the screen. **NOTE: If your internal reservoir cover has the optional chip baskets, do not stand on or in the baskets**.

If the expanded-metal screen or the optional chip baskets becomes clogged, the pump(s) may flood the false floor, resulting in cleaning solution or rinse water pouring over the doorframe into the front reservoir. Refer to section *"Troubleshooting."*

5.5. Troubleshooting

This section contains tables on the following problems:

- Water leaks over doorframe

Problem: Water leaks over doorframe	
Check This:	**Probable Cause(s)**
False floor screen area	Expanded-metal screen area clogged with bolts or other parts, gasket material, debris (clean screen)

Fig. 7 - 15: Troubleshooting: False Floor: Water Leaks Over Door Frame

6. 50 Hertz Electrical Power

This option is intended for installation sites that use 50 Hz electrical power instead of 60 Hz. The pump system has been reconfigured using V-belts to drive the pump, enabling a washer powered by 50 Hz to deliver the same performance as one powered by 60 Hz. This results in the same efficiency, pressures, and flows.

All other systems and components are the same.

6.1. Theory of Operation

The pump motor is no longer directly coupled to the pump. This option uses a V-belt drive to recover the loss in rpm and turn the pump at the same rpm it would turn at 60 Hz. The bigger sheave (pulley) is on the pump motor; the smaller, on the pump.

The pump motor is mounted on an adjustable base at the side of the reservoir. This allows for aligning the belt drive as well as tensioning the belt(s). Depending on the horsepower of the pump, the V-belt drive uses 1to 3 belts.

6.2. Installation

This option arrives factory-installed.

6.3. Operations

Operations are the same as those for a standard washer.

6.4. Maintenance

After the first 8 hours of operation, check belt tension and sheave alignment.

To adjust belt tension, *follow this procedure:*

1. Remove the *belt guard*.

2. Turn the upper and lower adjusting bolts on the motor's adjustable base to tighten or loosen belts. Turn each of the bolts *exactly* the same number of turns to maintain belt alignment.

3. Use a *belt tension checker* to verify proper tension. **NOTE:** Follow belt-tensioner directions for proper tension adjustment.

> **NOTE**: When a properly tensioned belt is running, the tight side of the belt forms a straight line from sheave to sheave. The slack side slightly bows.

To verify sheave alignment, *follow this procedure*:

1. Remove the *belt guard*.

2. Adjust belt tension.

3. Use a *level* to verify that the motor shaft and the pump shaft are parallel. (This prevents excessive wear of the sheaves and belts.)

4. Be sure that the sheaves are at the same height in the same plane, so that the belts run true.

Every 250 hours of operation:

- Visually inspect belt(s) for wear, and adjust tension as needed.

General Maintenance

- Keep belts clean. *Never* use belt dressing! This will damage belts and cause early failure.

- Be sure that air can circulate freely around the V-belt drive, and that temperatures are moderate. This will extend belt life.

- *Never* cover the expanded metal guards (vents) that protect the V-belt drive.

- Replace belts with original manufacturer's equipment or equivalent.
- Keep extra belts stored in a cool, dark, dry place.

6.5. Troubleshooting

This section contains tables on the following problems:

- Squealing sounds from pump area
- No wash cycle (no water pumped): simplex pump system
- Poor cleaning results *or* abnormal pump noise: duplex pump system

Problem:	***50 Hz electrical power -- Squealing sounds from pump area***
Check This:	**Probable Cause(s)**
Belt(s)	Slippage (tighten) Worn and frayed (replace)
Sheaves	Walls worn, with resulting belt slippage (replace)

Fig. 7 - 16: Troubleshooting: 50 Hz Electrical Power -- Squealing Sounds from Pump Area

Problem:	***50 Hz electrical power -- No wash cycle (no water pumped): simplex pump system***
Check This:	**Probable Cause(s)**
Belt(s)	Broken (replace)

Fig. 7 - 17: Troubleshooting: 50 Hz Electrical Power -- No Wash Cycle (No Water Pumped): Simplex Pump System

Problem:	***50 Hz electrical power -- Poor cleaning results or abnormal pump noise: duplex pump system***
Check This:	**Probable Cause(s)**
Main pump belt(s)	Broken (replace)
Booster pump belt(s)	Broken (replace)

Fig. 7 - 18: Troubleshooting: 50 Hz Electrical Power -- Poor Cleaning Results *or* Abnormal Pump Noise: Duplex Pump System

7. Filters

The optional *Filters* remove particles as small as 1 micron from the wash solution. If you have purchased this option, your MART representative will have worked with you to select a micron rating that best suits your washer's configuration and your applications.

When you purchase replacement filters, be sure the micron-rating is appropriate for your washer's configuration: A filter with extremely fine pores could significantly increase the pressure-differential and overload the capacity of the filter housing, affecting pump pressure and flow rate.

7.1. Theory of Operation

The two filter types are:

- Bag
- Cartridge

Filter Types

Bag filters are generally recommended for 50-100 microns, although they can filter down to 1 micron at lower flow rates. Bag filters are less expensive than cartridge filters, easier to change, and re-usable. One filter at a time is inserted into the housing. Bags are constructed of polypropylene, especially selected for reliable performance in a hot, caustic environment.

Cartridge filters are rated for 1-50 microns. Multiple filters may be inserted into the housing.

Filter housings have a swing-away lid. Filter elements are inserted into the housing from the top. The housing lid is tightened with swing-bolts.

The following table shows micron comparisons to guide you in selecting filters.

Micron Comparisons

Substance	***Microns***
Table salt	100
Human hair (avg. dia.)	50-70
White blood cell	25
Talcum powder	10
Cocoa	8-10
Red blood cell	8
Bacteria (cocci)	2

Fig. 7 - 19: Micron Comparisons

NOTE: The lower limit of visibility to the naked human eye is 40 microns.

Filtering System Configurations

There are two filtering system configurations. The following diagram shows solution flow:

Wash pump ➔	Filter ➔	Manifold (PBM)
Or		
Filter pump ➔	Filter ➔	Eductor nozzles (in reservoir)

The filter-pump-driven system allows for continuous filtering operation.

7.2. Installation

The filters are delivered installed, according to the configuration you specified.

7.3. Operations

The *wash-pump-driven configuration* is fully automatic and runs during the wash cycle.

To operate the filter-pump-driven configuration, *follow this procedure*:

1. Set the *filter-pump timer*, located in the washer's electrical control panel. The standard 5-hour timer is numbered 1-10 (each number represents a 1/2-hour increment). The timer controls the length of time the filter pump operates in *auto* mode, *if* you set the selector switch to *auto* (in the following step).

2. Set the filter pump's *selector switch*, located on the washer's control panel, to one of the following:

    - *Manual:* Activates the filter pump. It will run continuously.

    - *Off:* Turns the filter pump off.

    - *Auto:* Automatically activates the filter pump at the beginning of a wash cycle and runs the filter pump for the time indicated on the *filter-pump timer.*

7.4. Maintenance

Every 40 hours of operation:

- Check the filter elements. Replace dirty elements.

If you notice that cleaning results are not as good as usual, or that more time is necessary, check the filter elements. If they are dirty, replace them.

If your washer is equipped with the optional pressure-differential gauge, replace the filter when the pressure-differential has increased by 10 PSI (142 kg/cm^2) or more.

7.5. Troubleshooting

This section contains tables on the following problems:

- Wash load not clean
- Solution leaks from filter cover

Problem: Wash load not clean	
Check This:	**Probable Cause(s)**
Filter	Dirty (change filter)

Fig. 7 - 20: Troubleshooting: Wash Load Not Clean

Problem: Solution leaks from filter cover	
Check This:	**Probable Cause(s)**
Cover gasket	Dirty (clean)
Cover clamps	Loose (tighten)

Fig. 7 - 21: Troubleshooting: Solution Leaks from Filter Cover

8. Frequency Drive

The optional *Frequency Drive* is an electronic device that controls pump motor speed. The result is control of pressure and flow output.

8.1. Theory of Operation

The *Frequency Drive* is programmable for a variety of input, output, and performance configurations in industrial applications. It can be mounted on the washer cabinet, or in another, more convenient location. If the unit is remote-mounted, the power lines run from the washer's control panel to the *Frequency Drive*, and then to the pump motor.

Refer to the vendor-supplied manual for more information.

8.2. Installation

If you specify that your *Frequency Drive* be mounted on the washer cabinet, no further installation is required.

If you intend to remote-mount the *Frequency Drive*, follow the manufacturer's installation instructions, and make appropriate electrical connections.

> ***WARNING! If you have the Frequency Drive remote-mounted, be sure a qualified electrician does the work.***

8.3. Operations

Refer to the vendor-supplied manual for instructions on configuring the *Frequency Drive* input, output, and performance parameters in order to adjust the percent of full load, which adjusts pressure and flow. The following figure shows frequency drive results.

One benefit of reduced pressure is the ability to clean delicate parts.

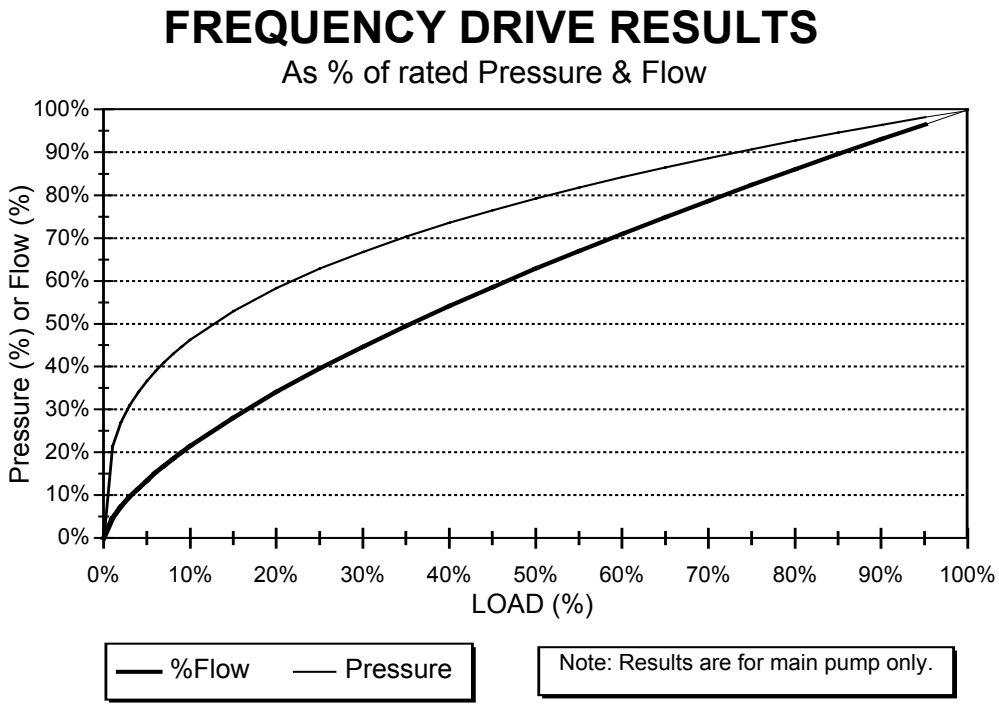


Fig. 7 - 22: Frequency Drive Results

8.4. Maintenance

Follow the manufacturer's recommended maintenance schedule and procedures for cleaning and oiling the fan.

8.5. Troubleshooting

This section contains tables on the following problems:

- Pump motor does not run

Problem: Pump motor does not run	
Check This:	**Probable Cause(s)**
Power	Not *ON*
Frequency drive	LED power indicator *not* lit (check power) LED fault-diagnostic indicator lit (refer to the vendor-supplied manual)

Fig. 7 - 23: Troubleshooting: Pump Motor Does Not Run

9. Hot-Air Blow-Off (HABO)

The optional Hot-Air Blow-Off (HABO) system "flash"-dries parts by high-velocity, direct blasts of air that blow most of the water off parts. Heat evaporates any remaining water.

All HABO systems are delivered with the following features:

- Heater contactor wired in-line with blower
- Over-temperature protection
- Duct-heater
- TEFC fan motor
- Direct-coupled aluminum, balanced fan blade
- High-velocity conversion nozzles 3 inches (7.6 cm) from the edge of the turntable

9.1. Theory of Operation

The HABO system activates after wash and rinse cycles have completed: The fan turns on while the turntable continues to rotate. Air is inducted from outside the washer cabinet by the fan and blown through the electric heating coils. The air picks up heat as it passes around the heating coils. Finally, the heated air is accelerated to high velocity as it travels through the plenum and out the nozzles to blow water off parts on the turntable.

The heating units are sized to provide a minimum of 110° F (43° C) rise above ambient to operating air temperature.

Steam-Exhaust Fan

NOTE: The HABO system removes steam using a variable-speed DC-drive centrifugal steam-exhaust fan, which replaces the standard ASE unit. The centrifugal fan differs from the standard unit in two keyways:

- The inlet is at a 90° angle from the outlet.
- The outlet ducting is *square* and connects to a *round* pipe.

Therefore, you must modify the standard installation procedures given in chapter *"Installation"* in this manual to account for these two differences. Refer to the following section, *Installation,* for more information.

The centrifugal fan runs at two speeds:

- *Low speed* provides normal steam exhaust. (It works similar to the auto steam exhaust [ASE] feature).
- *High speed* minimizes steam leakage from the cabinet during HABO.

Refer to the vendor-supplied cutsheet for instructions on setting fan speed.

Controlling HABO Heat

Thermocouples in the outside plenum on top of the washer cabinet and a temperature controller inside the electrical control panel control HABO heat.

NOTE: The *outside plenum* contains the blower unit, the thermocouples, and the heating element.

A redundant (back-up) heat-source measuring system works in conjunction with a high-level shutdown system to de-activate the HABO system if the heating element should overheat. Refer to section *"Troubleshooting."*

9.2. Installation

If you have a HABO system, you must modify standard ASE installation procedures. Refer to the following figures.

MART has available as an option flanged transition pieces to adapt the ASE fan to round ducting.

To install the HABO, *follow these guidelines*:

1. There are two couplings welded into the ASE fan blade housing. Use one of these couplings to connect a drain line back into the ASE ducting below the fan. This will allow condensed water vapor to drain back to the washer.
2. The output of the ASE fan can be rotated to any direction. Select a direction for the output that puts one of the two drain couplings on the fan in the DOWN position.
3. Remove the fan housing and rotate it to the selected direction.

4. During reassembly, thoroughly caulk all joints of the fan with a good-quality silicone caulk.

   Tip: Seal all joints with a 100% pure silicone caulking compound to prevent dripping and leaking from the steam in the exhaust.

   Tip: If at all possible, install the ASE fan **outside** to eliminate many of the nuisance dripping problems associated with steam condensing in the fan.

Tip: If your planned piping route contains any 90° elbows, install the fan at the elbow.

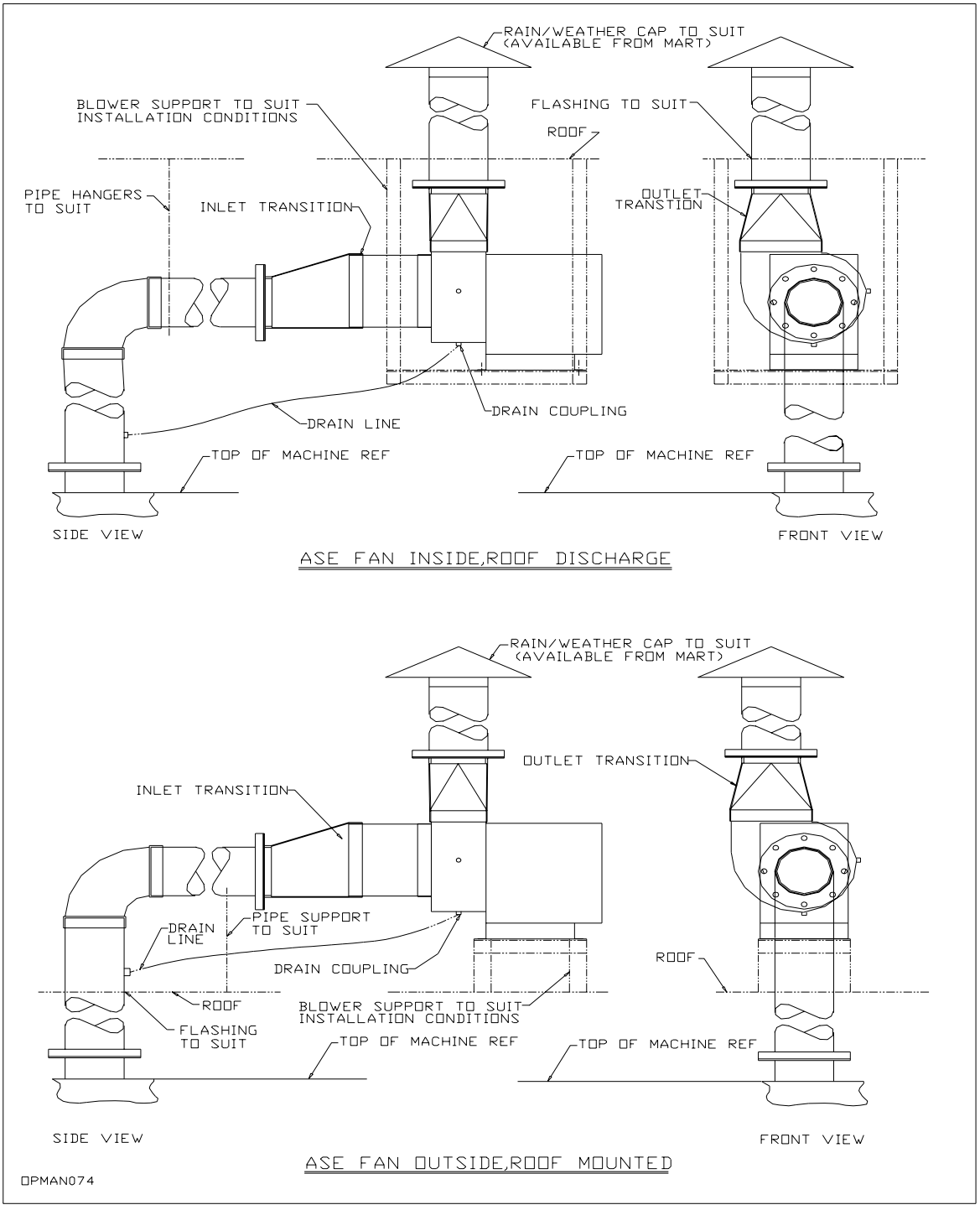


Fig. 7 - 24: HABO -- ASE Fan Installation

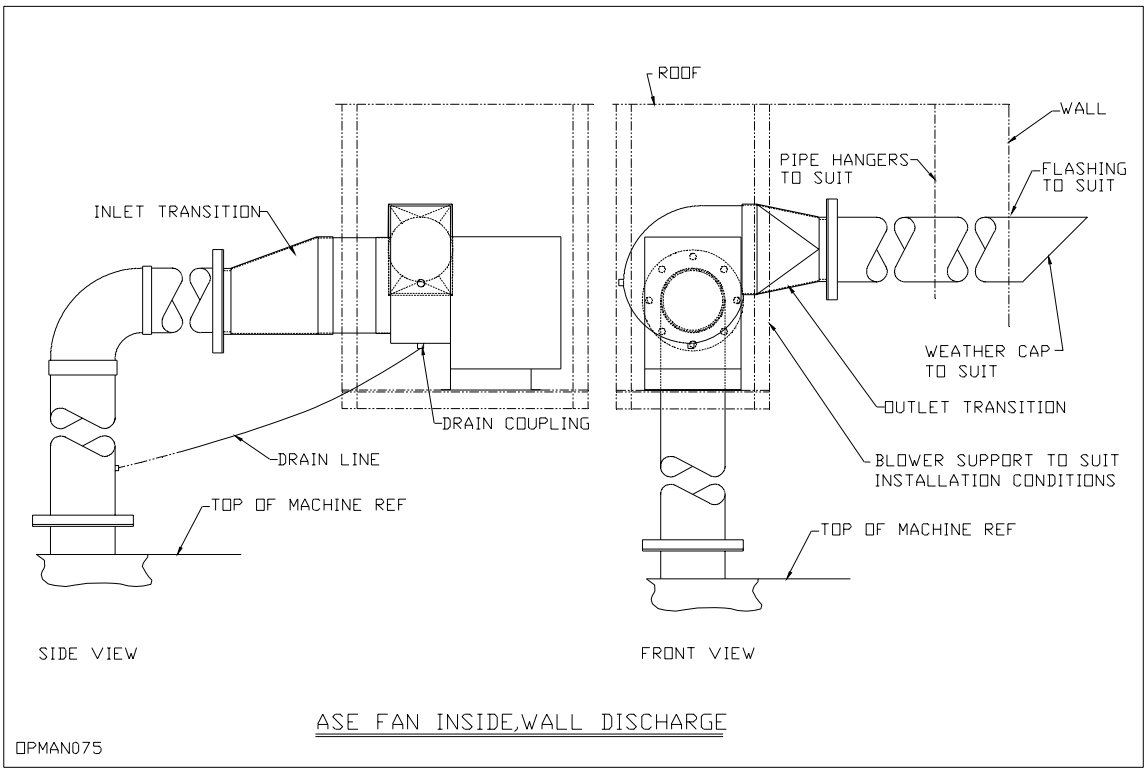


Fig. 7 - 25: HABO -- ASE Fan Installation

The HABO *inside plenum*, located in the washer cabinet and shown in the following figure, is always shipped installed.

The *outside plenum*, which contains the blower unit, the thermocouples, and the heating element, is shipped installed on smaller washers. You must install the outside plenum on larger washers.

To install the outside plenum on larger washers, *follow this procedure*:

1. Turn the *main power supply OFF*.
2. Mount the *outside plenum* on the washer *cabinet*.
3. Bolt the *plenum* to *connection points* on the *cabinet*.
4. Connect *heating-element wires* and *blower-motor wires* to the *conduit* on the washer Match corresponding wire *labels*.
5. Turn the *main power supply ON*.

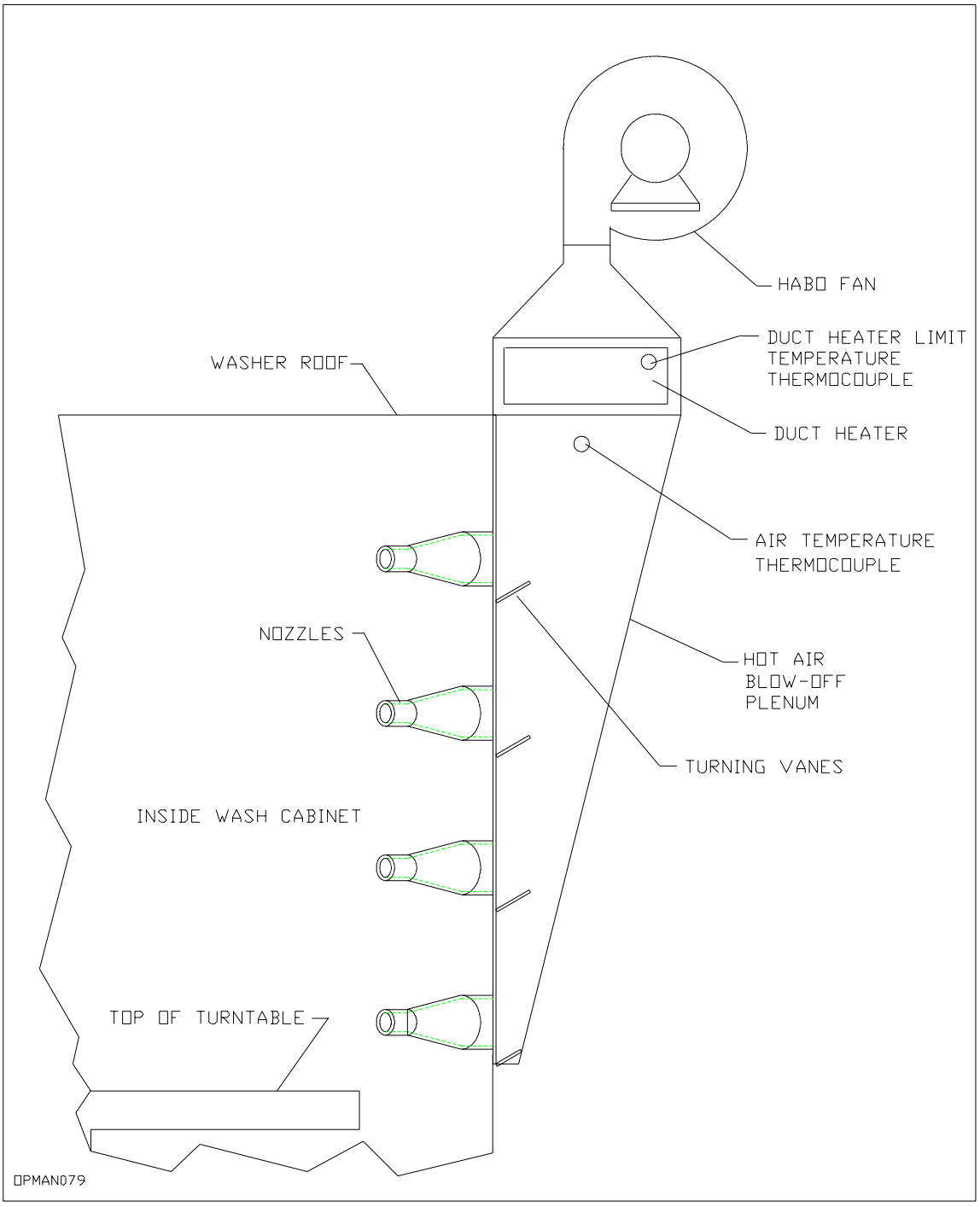


Fig. 7 - 26: Hot-Air Blow-Off (HABO) Inside Plenum

9.3. Operations

Refer to chapter *"Basic Operations"* for general washer operating procedures.

> ***WARNING! Turn the washer's main power supply OFF before opening the electrical control panel.***

Follow this procedure:

1. Position *parts on the turntable* so they will drain as best as possible. (Deep pockets or hidden areas will retain water.)

2. Place *parts as close to the nozzles as possible*. (Air velocity is highest near the outer edge of the turntable.)

3. Set the *HABO temperature controller* to the desired temperature. (The controller is located inside the electrical control panel.)

> ***WARNING! Do NOT set the HABO temperature controller above a maximum set point of 200°F (93° C)! Exceeding 200°F (93° C) may burn out the electric element, or trip the over-temp sensor system.***

4. Set the *HABO timer*, located inside the electrical control panel. Each numbered increment on the timer increases HABO duration by 30 seconds. The maximum run-time is 300 seconds. Examples are given in the following table.

HABO Timer Increments

Number	=	*Seconds*
1		30
2		60
3		90
↓		↓
10		300

5. Set the *HABO auto/off switch*, located on the control panel, to *auto*. This will activate the HABO system after the wash cycle, unless your washer is equipped with the optional auto rinse cycle (ARC). If your washer is so equipped, then the HABO system activates *after* the *rinse cycle*.

6. Refer to the vendor-supplied cutsheet for instructions on setting fan speed.

   If your washer is equipped with HABO, it is also equipped with auto steam exhaust (ASE). An added benefit of HABO is that you can also use the HABO steam-exhaust fan-speed control to adjust the amount of steam exhaust during ASE cycles.

   NOTE: If you set the ASE higher than the absolute minimum required for the desired rinse cycle, the steam exhaust wastes energy and raises operating costs. Initially, set the ASE speed control to the lowest setting that will satisfactorily keep steam in the washer during operation. If this setting does not provide an adequate rinse, adjust it higher for longer rinse cycles.

9.4. Maintenance

Every 1100 hours of operation:

- **Oil** the HABO blower motor with a standard electric-motor oil, suitable for small electric motors. For example, 10W-50 SAE oil.

  Refer to the vendor-supplied cutsheet for grease/oil points.

- **Inspect and clean** the electric heating coils:
  - Turn the *main power supply OFF*.
  - Remove the *coils* from the *upper plenum*.
  - Carefully clean any debris from the coils.
  - Insert the coils back in the upper plenum.
  - Turn the *main power supply ON*.

9.5. Troubleshooting

This section contains tables on the following problems:

- HABO heating element begins to overheat

Problem: HABO heating element begins to overheat	
Check This:	**Probable Cause(s)**
Fan	Not activating (check HABO selector switch, fuses)
Fan motor	Burned out Blown fuse
Fuses	Blown (pull out of electrical control panel to check) ... *and* ... *Be sure to shut off power **before** checking!*
Temperature controller	Heat set-point set too high (do not exceed 200°F/ 93° C)
Over-temp	Tripped (reset the over-temp device)

Fig. 7 - 27: Troubleshooting: HABO Heating Element Begins to Overheat

10. Jib Crane

The optional Jib Crane is designed to pick up parts in front of the reservoir and place them on the turntable. The crane is washer-mounted, with a hoist. The crane is sized by washer, with a load capacity compatible with that of the washer turntable. The maximum load capacity is stenciled on the boom.

NOTE: The jib-crane kit with trolley is supplied by MART. The hoist is provided by others, not by MART.

10.1. Theory of Operation

The operator pivots the horizontal lifting jib boom about a column located in the rear-center of the washer. A roller on the jib boom rides on a support over the top of the doorframe. Stops at each end of the support limit the arc-travel of the boom.

10.2. Installation

WARNING! Never cut or weld or add anything to the column or jib-crane structure!

Follow this procedure: (refer to the following two figures)

1. Mount the *column* on the *bolts* provided. The bolts are located at the rear-center of the washer. There are 2 bolts at the top of the washer cabinet, and 2 bolts at the bottom.

2. Tighten the *nuts and lock washers* on the bolts.

3. Mount the *boom track* on the *bolts* located over the top of the doorframe.

4. Make sure the *wheel stops* are at the *back of the washer* (not the front), near the column.

5. Do ***not*** tighten the boom-track bolts yet.

6. Mount the *center brace* on the *colum*n and the *boom track*.
7. Bolt the center brace to the column and the beam.
8. Tighten the boom-track *bolts*.

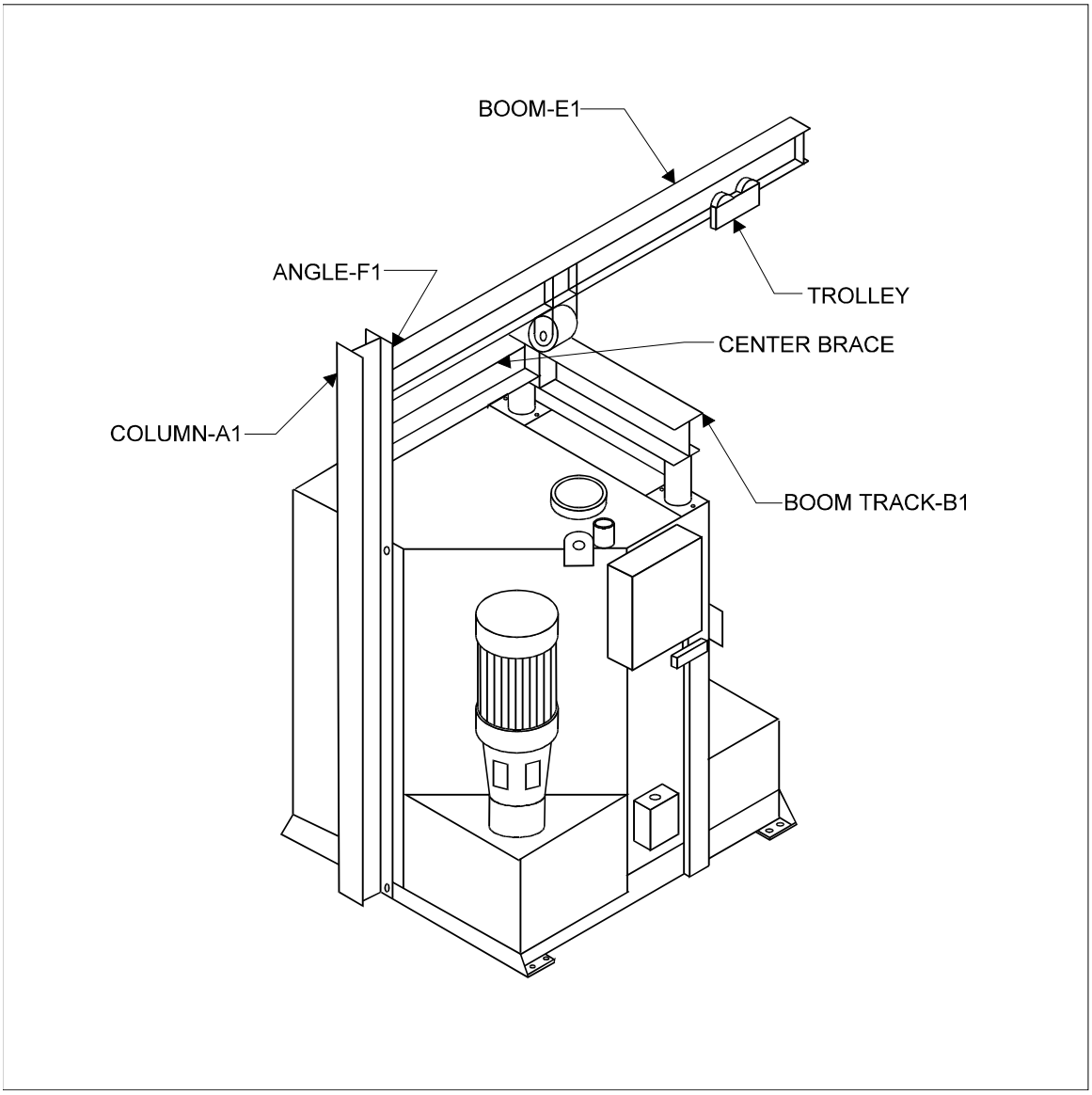


Fig. 7 - 28: Jib Crane, Washer-mounted

9. Insert the *jib-boom support-angle shaft* (pin) into the *bottom of the boom*. (Verify that there is a bronze bushing in the angle.)

10. Fit the *bronze washer* onto the ***top*** of the *boom shaft*.

11. Fit the *top support angle* onto the *shaft and the washer*. (Verify that there is a bronze bushing in the angle.)

12. Bolt the *angle* to the *column*.

13. Unbolt the *trolley stops* at the *front end* of the jib *boom*.

14. Slide the *trolley* onto the *jib boom*.

15. Re-bolt the *trolley stops* to the *front* of the jib *boom*.

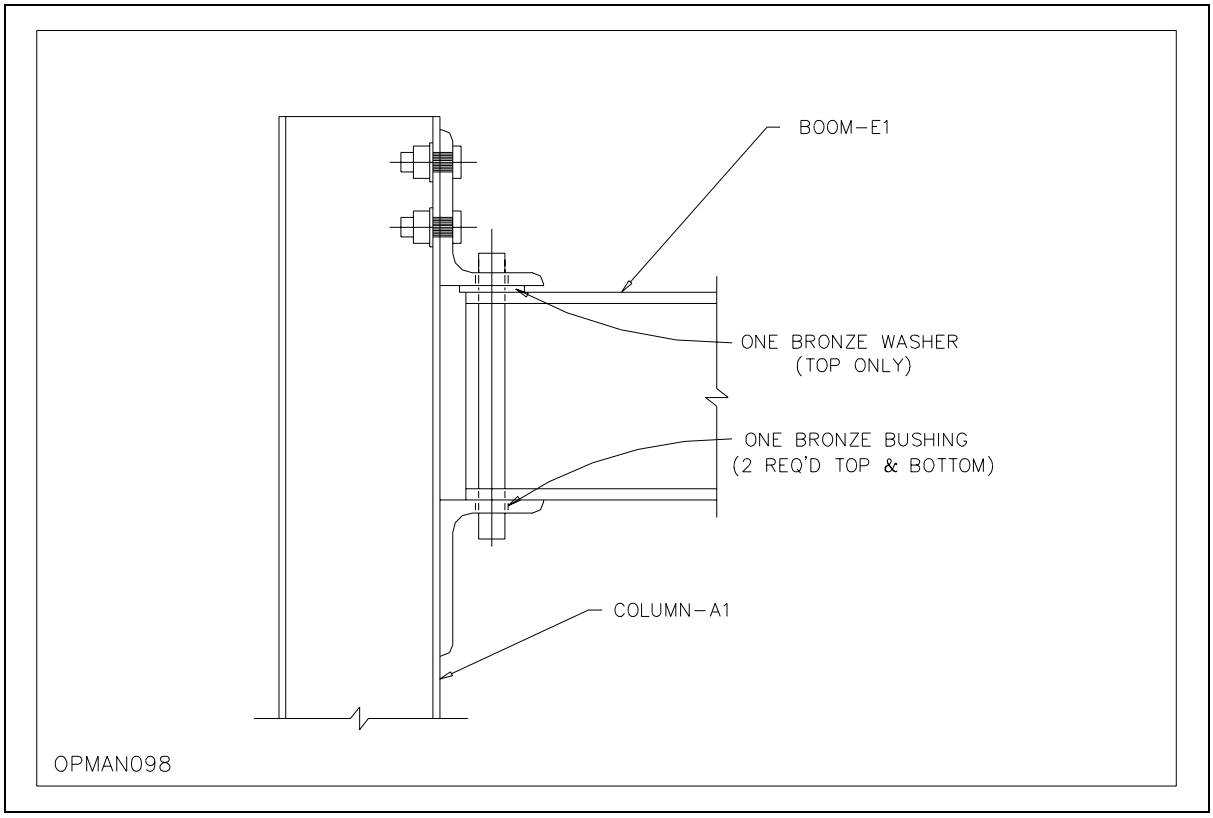


Fig. 7 - 29: Jib Boom: Bronze Bushing and Washer Locations

Since the boom is a lifting device, be sure to check the installation work:

1. Swing the *boom* manually -- and *carefully* -- to be sure it moves freely.
2. Check all *bolts* for tightness.
3. Check the *jib-boom wheel* located at the top-front of the cabinet above the door, to be sure that the *shaft pin* is actually all the way through the wheel and held in place by the cotter pin.

10.3. Operations

WARNING! Be sure you have anchored the washer to the floor BEFORE using the Jib Crane! DO NOT OPERATE the Jib Crane if you have not anchored the washer to the floor -- the washer could tip over and severely injure or kill the operator!

WARNING! Be sure the washer reservoir is filled to capacity with solution BEFORE using the Jib Crane! DO NOT OPERATE the Jib Crane if you have not filled the reservoir to capacity with solution -- the washer could tip over and severely injure or kill the operator!

To **load a part using the Jib Crane**, *follow this procedure*:

1. Hold the *door position-lock handle up* and push the door *slowly* away from the cabinet *past the first position lock* (wider than a 90° angle from the washer frame).
2. Move *parts* up to the front reservoir.
3. Attach the *hoist* to a part.

4. Lift the part.
5. Rotate and hold the *door position-lock handle up*, and push the door *slowly* toward the cabinet, until it locks in the first (90° angle) position.
6. Move the part over the *center* of the *turntable*.
7. Lower the part to the turntable.
8. Remove the hoist from the part.

To **unload a part from the washer using the Jib Crane**, *follow this procedure*:

1. Pull the door open *slowly*, until it locks in the *first* position (90° angle from cabinet frame).
2. Use the *"jog" button*, located on the control panel, to *rotate the turntable* for easy access to the *part* you wish to unload.
3. Attach the *hoist* to a *part*.
4. Lift the part.
5. Rotate and hold the *door position-lock handle up* and push the door *slowly* away from the cabinet *past the first position lock* (wider than a 90° angle from the washer frame).
6. Lower the part to the *transporter*.
7. Remove the hoist from the part.

10.4. Maintenance

Inspect the jib crane according to OSHA 29CFR Section 1910.179.

Every 160 hours of operation:

- Inspect the bronze washer on the boom shaft to be sure it is in good condition. Replace the washer if it is worn.

Every year inspect the jib crane for the following:

- Swing the boom manually -- and carefully -- to be sure it moves freely.
- Check all bolts and parts for tightness.
- Check the jib-boom wheel located at the top-front of the cabinet above the door, to be sure that the shaft pin is actually all the way through the wheel and held in place by the cotter pin.
- Verify that there are no permanent distortions; or cracked or corroded members.

Repair or replace parts as needed.

10.5. Troubleshooting

This section contains tables on the following problems:

- Boom does not swing freely

Problem: Boom does not swing freely	
Check This:	**Probable Cause(s)**
Bronze washer	Bronze washer on boom shaft has worn (replace)
Jib-boom wheel track	Dirty

Fig. 7 - 30: Troubleshooting: Boom Does Not Swing Freely

11. Oil Skimmer

The optional Oil Skimmer removes from the surface of the power washer's sump floating oils, greases, sludge, fatty acids and other contaminants that cling to the wheel. These contaminants cling to the rotating skimmer wheel, and are then scraped off into a container by spring-loaded wiper blades. Water is not removed.

The skimmer provides these benefits:

- Extension of cleaning-solution life
- Better cleaning results
- Reclamation of oil in many cases

11.1. Theory of Operation

The Oil Skimmer is mounted in a small box on the side of the power washer cabinet. Refer to the following figure.

Skimmer Assembly: The skimmer is electrically connected to the washer by a standard 120V 3-prong grounded plug. It is operated by a single-phase, 60-cycle gear motor. The skimmer is lightweight and has only one moving part.

The skimmer's *manual/off/auto* switch is located on the washer's control panel.

Skimmer Function: The lower part of the skimmer wheel is submerged in the solution. As the wheel rotates, it picks up oil and other clinging contaminants from the surface of the solution. The contaminants are collected in the run-off trough and directed to a suitable disposal container. The skimmer will remove up to 1 1/2 gallons (5.7 liters) of contaminants each hour.

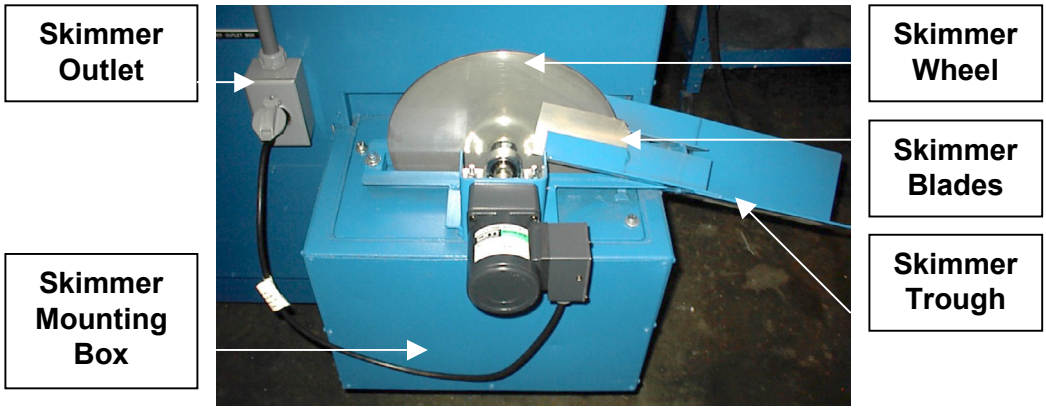


Fig. 7 - 31: Oil Skimmer Assembly

11.2. Installation

Follow this procedure:

1. Unpack the *skimmer assembly* from the turntable inside the washer cabinet.
2. Set the *assembly* into the *skimmer box*.
3. Tighten the *wing nut*.
4. Attach the *grounded plug to the outlet* on the *washer*.

11.3. Operations

The Oil Skimmer is designed to operate when the washer is in use, *or* after hours, when the washer is in "shut-down" (*off*) mode.

To operate the Oil Skimmer, *follow this procedure*:

1. Set the skimmer's *selector switch*, located on the washer's control panel, to one of the following:
    - *Manual:* Activates the skimmer. It will run continuously.
    - *Off:* Turns the skimmer off.
    - *Auto:* Automatically activates and runs the skimmer according to the program set for circuit #2 of the 7-day clock.

    NOTE: You *must* program the 7-day clock's circuit #2 for *ON/OFF* times, and set the skimmer's selector switch to *auto.*

NOTE: Oil skimming works best when the emulsified oils are allowed time to float and collect on the surface of the solution. Program your 7-day clock circuit #2 to run the Oil Skimmer several hours after washer shutdown in order to achieve the best oil-skimming results. Also, some defoamers float on the surface at higher temperatures. By skimming when the solution is cooler, less defoamer will be skimmed off with the oils.

11.4. Maintenance

Every 1100 hours of operation:

- **Oil** the skimmer motor with a standard electric-motor oil, suitable for small electric motors. For example, 10W-50 SAE oil.

  Refer to the vendor-supplied cutsheet for oil points.

During sludge clean out:

- **Clean** the wheel and frame. If necessary, remove the skimmer assembly and box cover to clean sludge out of the box.

  Refer to chapter *"Maintenance"* for more information on sludge clean out.

11.5. Troubleshooting

This section contains tables on the following problems:

- Skimmer-wheel does not skim

Problem: Skimmer-wheel does not skim	
Check This:	**Probable Cause(s)**
Drain trough	Clogged
Blades	Not contacting wheel: Bend to adjust Replace if worn
Wheel	Not turning (check/tighten shaft nuts)
Motor	Motor not turning (115 V): Fuse needs to be replaced Wires need to be tightened Motor needs to be replaced

Fig. 7 - 32: Troubleshooting: Skimmer-Wheel Does Not Skim

12. Power-Assisted Door

The optional *Power-Assisted Door* supplies power to the door of the washer cabinet, which makes heavier-weight loads easier to handle: the operator can easily open and close the door weighted with up to 20,000 pounds (9070 kg) of load.

> **NOTE**: The door can be operated manually, without power-assist.

12.1. Theory of Operation

The *Power-Assisted Door* is pneumatically powered. A tandem air/hydraulic cylinder dampens and smoothes door operation. Speed-control valves on top of the cabinet can be adjusted to regulate the general range of opening and closing speed.

You can fine-tune your control of the speed at which the door opens and closes by raising and lowering the position-lock handle, which is located at the bottom of the door. The handle works like a throttle to increase and decrease speed.

12.2. Installation

The *Power-Assisted Door* is shipped installed on the cabinet. The speed-control valves are factory pre-set for a moderate opening and closing speed range.

12.3. Operations

> ***WARNING! NEVER put hands, legs, or head inside the door! This could result in severe injury or death!***

> ***WARNING! Before you attempt to open or close the power-assisted door, be sure you have enough clearance for the full arc-travel of the door as it swings!***

WARNING! NEVER swing the power-assisted door open to a position lock at an accelerated speed! Control the speed of the door by the position-lock handle, located at the bottom of the door. Use the handle like a throttle to adjust speed.

To operate the door, *follow this procedure*:

1. Select *open* or *close* on the *power-assist selector switch*, located on the front of the door.
2. Unlatch the door, if it is latched.
3. Lift and hold the *position-lock handle up* to keep the power-assist activated.
4. Release the handle to stop the power-assist.

The position-lock handle is located at the bottom of the door. The two position lock slots hold the door open at approximately a 60° angle and a 90° angle, respectively, from the front of the cabinet.

Securing the Door

Always be sure that the open door is locked in position:

- Visually check the position lock slot, *or*
- Try to pull or push the door

Refer to chapter *"Basic Operations"* for more general information on opening and closing the door.

12.4. Maintenance

Every 160 hours of operation:

- Check the filter/regulator/lubricator unit. The lubricator has an oil reservoir, and is located on the right side of the washer. Add oil, if required, to the fill-level.

Refer to your vendor-supplied cutsheet for instructions.

12.5. Troubleshooting

This section contains tables on the following problems:

- Power-assist does not activate

Problem: Power assist does not activate	
Check This:	**Probable Cause(s)**
Control valve	Stuck (replace)
Position-lock handle limit switch	Defective
Selector switch	Defective
Air-pressure	Not in the 75-100 PSI [1000-1400 kg/sq cm] range (check air-supply system)
Electric solenoid	Burned out (replace)

Fig. 7 - 33: Troubleshooting: Power-Assist Does Not Activate

13. Pump Pressure Control Valve and Gauge

The optional pump pressure control valve allows the operator to adjust water flow and pressure to the power blast manifold (PBM). The pressure gauge indicates the amount of pressure.

13.1. Theory of Operation

The operator turns the control valve clockwise to close it, decreasing water flow to the PBM. The reduced flow results in lower pressure through the PBM nozzles. The valve will not slip, so pressure remains exactly as adjusted.

> **NOTE**: When the control valve is fully closed, the water line still carries the minimum water flow necessary to avoid damage to the pump.

A coupling welded into piping between the pump and the PBM is used as a pressure tap point for a glycerin-filled pressure gauge. The pressure tap piping is a large diameter for easy clean out.

The pressure gauge assembly includes a diaphragm seal that prevents solution from entering the gauge. Pressure on the diaphragm is transmitted through the glycerin inside the gauge to the reading dial.

13.2. Installation

This option arrives factory-installed.

13.3. Operations

While the wash pump is running, turn the control valve until the pressure you wish is indicated on the pressure gauge.

13.4. Maintenance

WARNING! NEVER disconnect the pressure gauge from the diaphragm seal! Glycerin will leak out and damage the gauge assembly!

If the gauge does not read pressure, ***and*** the control valve is open, *follow this procedure*:

1. Unscrew the diaphragm seal and gauge *together*.
2. Clean the gauge pipe out.
3. If the problem persists, replace the gauge and diaphragm-seal assembly.

13.5. Troubleshooting

This section contains tables on the following problems:

- Pump pressure gauge does not work

Problem: Pump pressure gauge does not work

Check This:	Probable Cause(s)
Gauge pipe	Clogged (clean out)
Gauge	Damaged (replace)
	Glycerin leakage (replace)
Diaphragm seal	Damaged (replace)

Fig. 7 - 34: Troubleshooting: Pump Pressure Gauge Does Not Work

14. Pump Pressure Gauge

The optional pressure gauge indicates the amount of pressure in the piping from the wash pump to the power blast manifold (PBM).

14.1. Theory of Operation

A coupling welded into piping between the pump and the PBM is used as a pressure tap point for a glycerin-filled pressure gauge. The pressure tap piping is a large diameter for easy clean out.

The pressure gauge assembly includes a diaphragm seal that prevents solution from entering the gauge. Pressure on the diaphragm is transmitted through the glycerin inside the gauge to the reading dial.

14.2. Installation

This option arrives factory-installed.

14.3. Operations

There are no operator instructions. The pump pressure gauge will indicate the pressure in the piping from the wash pump to the power blast manifold (PBM).

14.4. Maintenance

> ***WARNING! NEVER disconnect the pressure gauge from the diaphragm seal! Glycerin will leak out and damage the gauge assembly!***

If the gauge does not read pressure, *follow this procedure*:

1. Unscrew the diaphragm seal and gauge *together*.

2. Clean the gauge pipe out.
3. If the problem persists, replace the gauge and diaphragm-seal assembly.

14.5. Troubleshooting

This section contains tables on the following problems:

- Pump pressure gauge does not work

Problem: Pump pressure gauge does not work	
Check This:	**Probable Cause(s)**
Gauge pipe	Clogged (clean out)
Gauge	Damaged (replace) Glycerin leakage (replace)
Diaphragm seal	Damaged (replace)

Fig. 7 - 35: Troubleshooting: Pump Pressure Gauge Does Not Work

15. Rack and Fixture Set, or Small-Parts Basket

All parts must be secured to the turntable during the cleaning cycle. To do this, use the following:

- Rack and fixture set
- Small-parts basket

Refer to chapter *"Basic Operations - Loading and Securing Parts"* for information on using securing devices.

15.1. Theory of Operation

The rack and fixture set and small-parts basket are optionally available from MART. Refer to the following two figures.

You may want to discuss your requirements with your MART representative, especially before you alter or add to the basic configuration to customize it for an application.

15.2. Installation

There is no installation required. The rack and fixture set and small-parts basket arrive ready to use.

NOTE: Large racks or fixtures may need to be assembled.

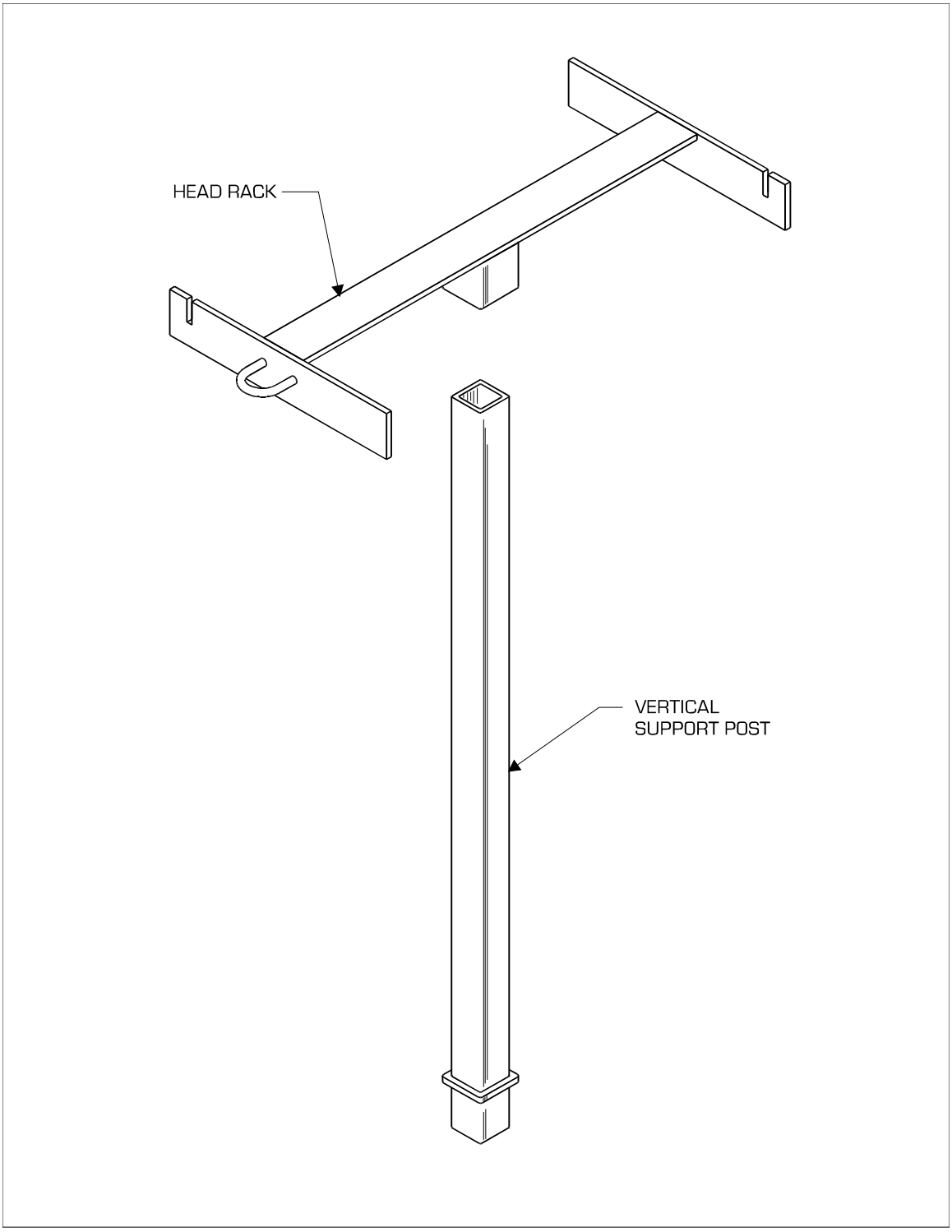


Fig. 7 - 36: Rack and Fixture Set

15.3. Operations

Refer to chapter *"Basic Operations - Loading and Securing Parts"* for information on using securing devices with the rack and fixture set.

To use the rack and fixture set, *follow this procedure*:

1. Select the appropriate 16-inch (40.6 cm) or 32-inch (81.3 cm) vertical post.
2. Insert it into a *turntable socket* that will position the *load nearest the center* of the turntable and ensure that no part of the load will hang outside the turntable.
3. Attach a *head rack* or other *fixture* to the *top* of the *centering vertical post,* facing the center of the turntable.
4. Load the *part* vertically inside the head rack or fixture.
5. Attach *securing devices*, as described in chapter *"Basic Operations - Loading and Securing Parts."*

To use the small-parts basket, *follow this procedure*: (refer to the following figure)

1. Load *small parts* into the *basket*.
2. Secure the *lid*.
3. Place the basket on the *center* of the *turntable*.
4. Attach *one end of the chain* to a *hook* located on the inner surface of the *turntable*'s outer rim.
5. Run the chain through both *basket handles*.
6. Attach the *end of the chain* or a *link* to a *hook,* located on one end of the load binder.
7. Attach the *hook* on the *other end* of the load binder to a *chain eyelet* directly across (180° angle) from the first hook.
8. Tighten the chain with the provided *load binder*.

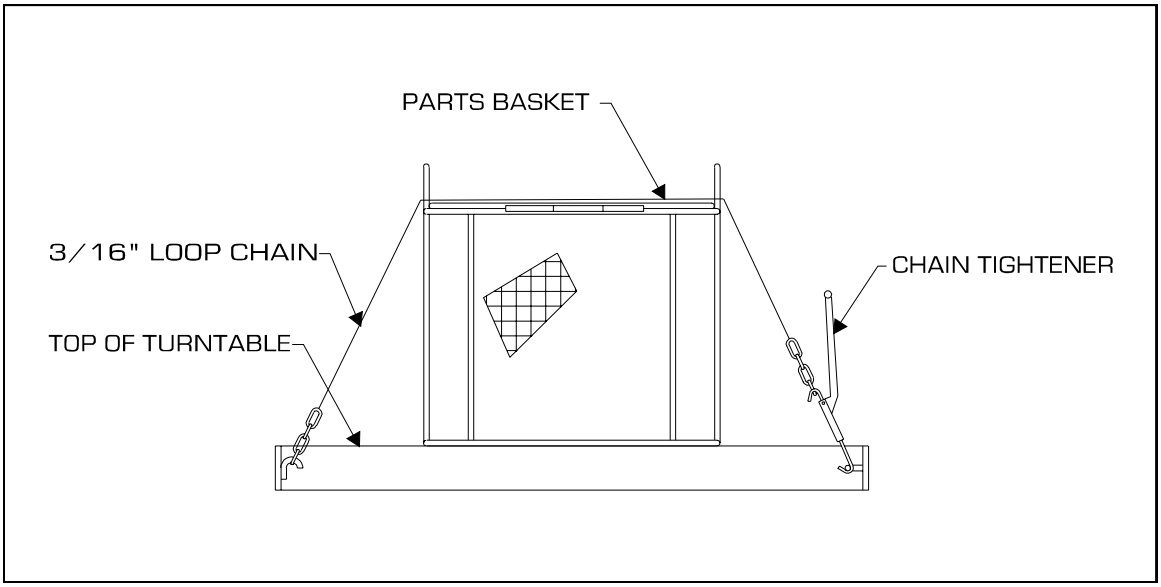


Fig. 7 - 37: Small-Parts Basket

15.4. Maintenance

Clean racks, fixtures, and baskets as required.

15.5. Troubleshooting

If you properly secure all parts, using racks, fixtures, small-parts baskets, and appropriate securing devices, no problems should arise from these options.

16. Remote Grease Fittings

The optional *Remote Grease Fittings* allow you to grease the turntable or the Power Blast Manifold (PBM) swivel bearings from the outside of the washer cabinet.

16.1. Theory of Operation

This option eliminates the need to disassemble any part of the washer or to get inside the cabinet in order to grease the turntable or the Power Blast Manifold (PBM) swivel bearings. It improves accessibility, reducing maintenance time.

This option is available for any bearing in the washer.

16.2. Installation

The optional *Remote Grease Fittings* are delivered installed, according to your specifications.

16.3. Operations

The *Remote Grease Fittings* are located on the nearest outside surface of the washer to the bearing. They are placed at a convenient height for the operator.

The remote turntable grease point is on the cabinet door. The remote swivel grease point is on the wash manifold side of the washer near the door.

16.4. Maintenance

None.

16.5. Troubleshooting

None.

17. Rinse Wand

The Rinse Wand is an optional addition to the standard rinse system. Its purpose is to manually rinse spot areas after a wash cycle.

The Rinse Wand consists of a gun-shaped handle with an extended tube that has a spray nozzle at its apex. The spray wand is hand-operated. Whenever the operator depresses the trigger, water from the supply line is released through the nozzle at line pressure.

NOTE: The water from the wand is not heated, and contains no chemicals.

17.1. Theory of Operation

Supply-line water pressure powers the spray. The wand uses a two-gallon-a-minute fan-shaped nozzle. Since water from spray is normally returned to the water reservoir, a solenoid valve connected to the solution-level control system disallows spray-wand use whenever the solution level is at the HIGH-HIGH (maximum) mark. A light on the control panel indicates this condition.

17.2. Installation

This option is factory-installed.

17.3. Operations

After a cleaning cycle has completed, open the washer door to the first door-position lock stop. Use the *jog button* to rotate the turntable as you inspect the wash load for any area that may need additional rinsing. If you find such an area, release the *jog button* to stop the turntable.

WARNING! Be sure to wear protective gear (face shield, gauntlet gloves, rubber apron)! Spray could be deflected back at you and could contain chemical residue that could cause serious chemical and scald-type burns to eyes and skin!

Follow these operating guidelines:

1. Stand back several feet from the washer.
2. Aim the wand at the part.
3. Pull the trigger and direct the spray to the area that needs to be rinsed.

Remember the following:

- Wand water is not heated. It will not flash-dry as quickly as rinse water in the washer.
- Wand water returns to the reservoir and uses part of the rinse-bank (*rinse-bank* is the available volume for rinse water). Therefore, use of the wand could result in shortened rinses or no rinse at all. Keep rinse-wand use to a minimum to avoid this problem.
- Rinse-wand water contains no chemical additives such as rust inhibitor. Therefore, excessive use of the wand could cause rusting of parts.

17.4. Maintenance

Lubricate the gun trigger periodically.

17.5. Troubleshooting

This section contains tables on the following problems:

- No hand rinse

Problem: No hand rinse	
Check This:	**Probable Cause(s)**
Light on control panel	Solution level at HIGH-HIGH (maximum) mark
Solenoid	Failed (replace)
Nozzle	Clogged (remove and clean)

Fig. 7 - 38: Troubleshooting: Rinse Wand: No Hand Rinse

18 Sludge Scraper

The Sludge Scraper removes sludge from the power washer's reservoir to a bin or barrel. The materials to be removed by the sludge scraper can be any solid material or any material that is of a consistency that will not run off of the scraper bars.

The sludge scraper provides these benefits.

- Extension of cleaning-solution life
- Better cleaning results

18.1. Theory of Operation

The washer is mounted on the sludge-scraper assembly, which replaces the original floor of the washer's reservoir. Part of the assembly extends as a chute behind the washer at a 45-degree angle.

When the Sludge Scraper is operating, angle scrapers move across the bottom of the reservoir, collecting sludge and carrying it up the chute. At the end of the chute, the sludge drops into a bin or barrel. The scrapers then move back down the chute into the washer reservoir and begin to scrape the bottom of the reservoir.

The scrapers are attached to a sprocket-mounted drag chain that continuously rotates. The drag chain is chain-driven by a gear motor through a sprocket torque-limiter.

The gear motor is a variable-speed DC-drive motor, with a speed controller located in the washer's electrical control panel. You can set the motor from low to high speed.

An external view of the sludge scraper is shown in the following figure.

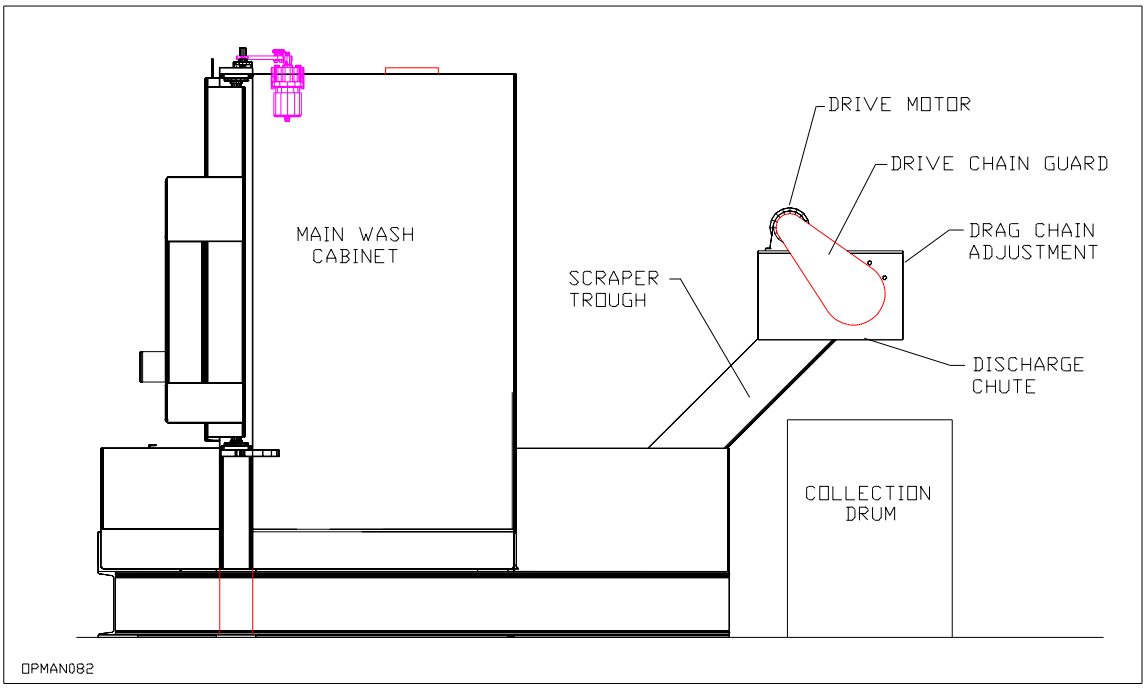


Fig. 7 - 39: Sludge Scraper -- External View

18.2. Installation

The Sludge Scraper is factory-installed.

18.3. Operations

The Sludge Scraper is designed to operate when the washer is in use, or after hours, when the washer is in "shut-down" (off) mode. A forward and reverse jog feature is provided to help free any scraper jams.

> WARNING! NEVER put your hands into the scraper chute! This could result in severe injury.

To operate the Sludge Scraper, follow this procedure:

> WARNING! Disconnect power before opening the control panel.

1. Set the Sludge Scraper timer, located in the washer's electrical control panel. The standard 10-hour timer is numbered 1-10 (each number represents a 1 hour increment). The timer controls the length of time the scraper operates in auto mode, if you set the selector switch to auto (in the following step).

2. Set the scraper's selector switch, located on the washer's control panel, to one of the following:

    - Manual: Allows manual operation of the sludge scraper using the jog buttons.

    - Off: Turns the scraper off.

    - Auto: Automatically activates and runs the scraper for the time indicated on the scraper timer. The scraper will restart start when a wash cycle begins and continues for the time set after the last wash cycle. If another wash cycle is started before the timer times out the timer is reset with the last wash cycle.

To operate the jog function, follow this procedure:

1. Set the selector switch on the control panel to manual.

2. Go to the sludge scraper's discharge area and press the forward or reverse jog button located in the small sludge scraper control panel.

18.4. Maintenance

Every 40 hours of operation:

Check chain tension.

If you need to adjust the tension of the drag chain, tighten the bolts on the take-up frame so that the drive sprocket moves back and up. Adjust both sides of the chain.

Adjust the drive chain (from the motor to the torque limiter) by sliding the motor.

Follow the manufacturer's recommendations for adjusting the torque-limiter.

Lubricate the take-up bearings. The grease fittings are located at the chute end of the sludge scraper.

Every year:

Check the DC motor brushes for wear. Replace as needed.

A diagram of the scraper is shown in the following figure.

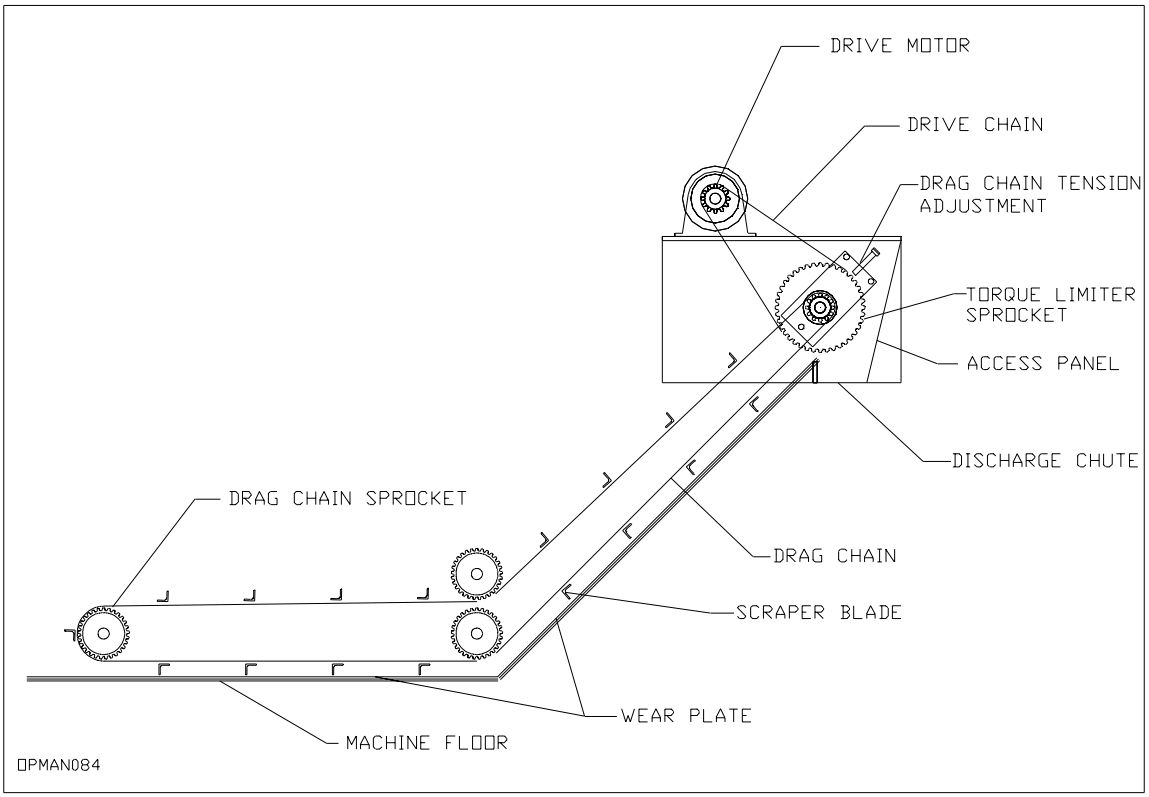


Fig. 7 - 40: Sludge Scraper -- Diagram of Parts

18.5. Troubleshooting

This section contains tables on the following problems:

- Sludge scraper drag chain does not move

Problem:	Sludge scraper drag chain does not move
Check This:	**Probable Cause(s)**
Chain	Caught on something (Use reverse jog) Broken Drive sprocket too loose (adjust tension -- tighten)
Sprockets	Chain is not on sprockets
Torque-limiter	Not adjusted correctly
Motor	Motor not turning: Selector switch OFF 7-day clock not set properly Fuse needs to be replaced Wires need to be tightened Replace brushes Motor needs to be replaced

Fig. 7 - 41: Troubleshooting: Sludge Scraper Drag Chain Does Not Move

19. Short High Impact Manifold (SHIM) System

The Short High Impact Manifold (SHIM) is designed to give you the advantage of two machines in one. A standard work height machine and a shorter work height, ultra high impact machine. When retracted you have the benefit of the entire Cabinet height to wash tall parts and, when deployed, all the blasting energy is concentrated into a smaller work area for shorter loads and baskets of parts.

19.1. Theory of Operation

Two Power Blast Manifolds are coupled together, and a set of valves directs the flow to one of the Manifolds. The Standard PBM is full height and SHIM, when deployed, reduces the work height by approximately one-half. The SHIM Manifold has a fold down horizontal upper arm. The vertical sections of the standard and SHIM manifold have the same number of nozzles so that the nozzles in the SHIM are packed more tightly together. The nozzles in the standard Manifold have a 25 degree blast pattern while the SHIM has narrower15 degree pattern nozzles, thus more than doubling the impact pressure for shorter wash loads. A SHIM manifold is shown in the following figure.

19.2 Operations

Choose the proper manifold with the selector valve. Refer to the selector valve schematic diagram below and on the front of the Power Washer door for manifold selection.

To deploy the SHIM, reposition the PBM selector valve handle, remove the locking pin in the fold down arm section, pivot the arm to its horizontal position, and replace the locking pin to hold the horizontal SHIM arm in place.

> Be sure the fold down arm is locked in the proper position for the height of the wash load. A tall wash load may hit the fold down arm and damage the PBM drive

> Do not walk on the internal reservoir cover to raise or lower the fold down arm or to switch the selector valve. Stand on the outside reservoir lid and reach into cabinet to make adjustments.

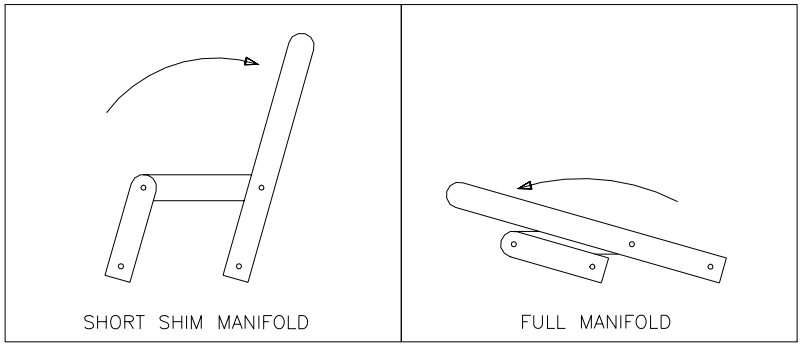


FIGURE 7-42 SHIM MANIFOLD SELECTOR VALVE SCHEMATIC

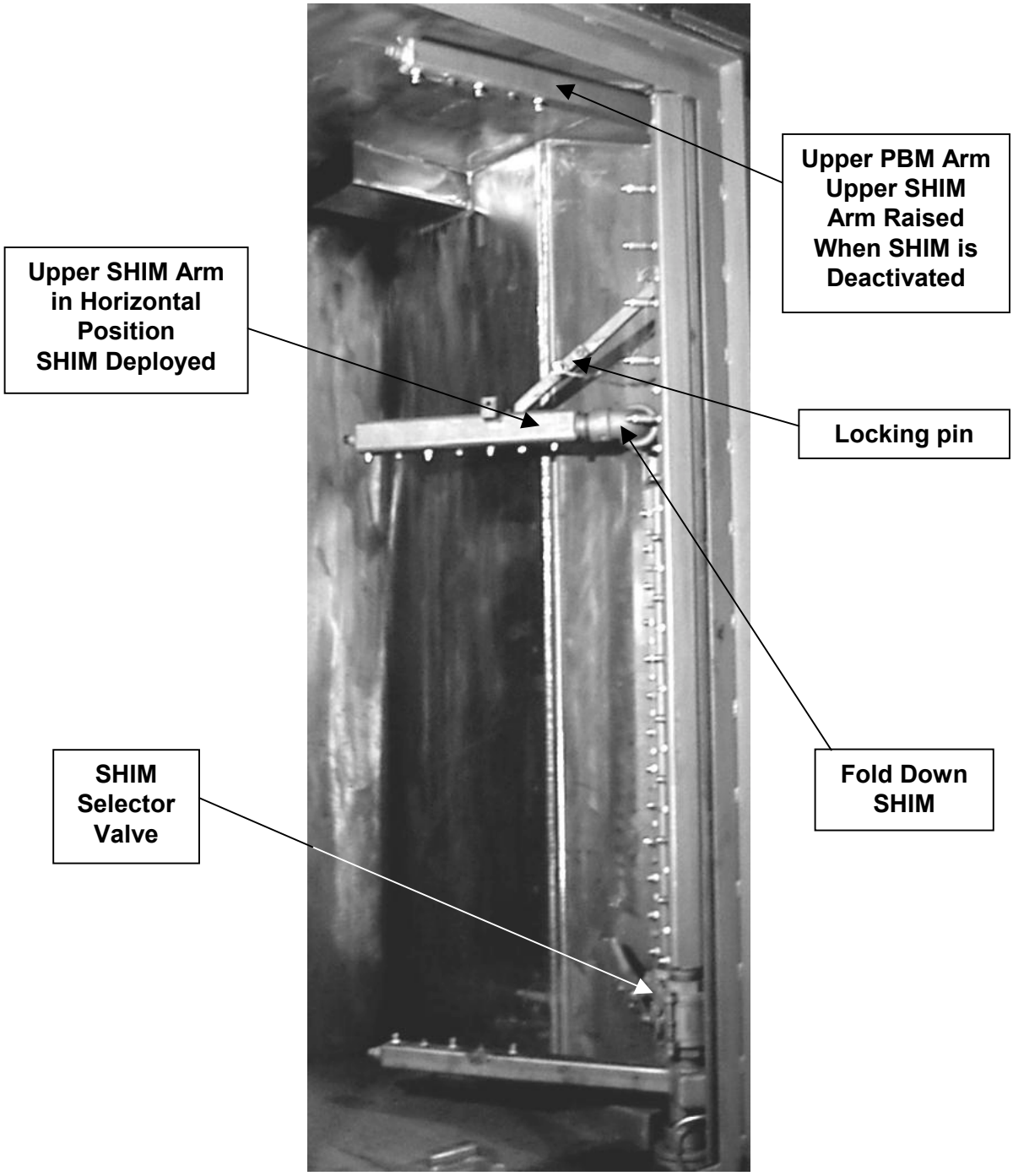


Fig. 7-43: SHIM Manifold System Tornado 40 HP

19.3. Maintenance

Lubricate Fold down Arm Swivel every 8 hours of operation or as required.
Replace worn nozzles in both manifolds as required to prevent overloading of pumping system

19.4 Troubleshooting

Use procedures in chapters *"Installation," "Advanced Operations: Process-Control,"* or *"Maintenance"* to correct a problem after you have diagnosed it.

Or, refer to your vendor-supplied manuals or cut sheets for instructions on correcting problems.

This section contains tables on the following problems:

- PBM not oscillating

Problem: PBM not oscillating	
Check This:	**Probable Cause(s)**
Linkage	Not connected Out of adjustment Loose Not connected to shaft
Bearings	Failed
Swivel	Not properly adjusted Not lubricated Not moving freely
PBM gear motor	Not rotating (check wires/fuses/overload tripped)
PBM mounting plate	Motor not securely attached to it

Fig. 7 - 44: Troubleshooting: PBM Not Oscillating

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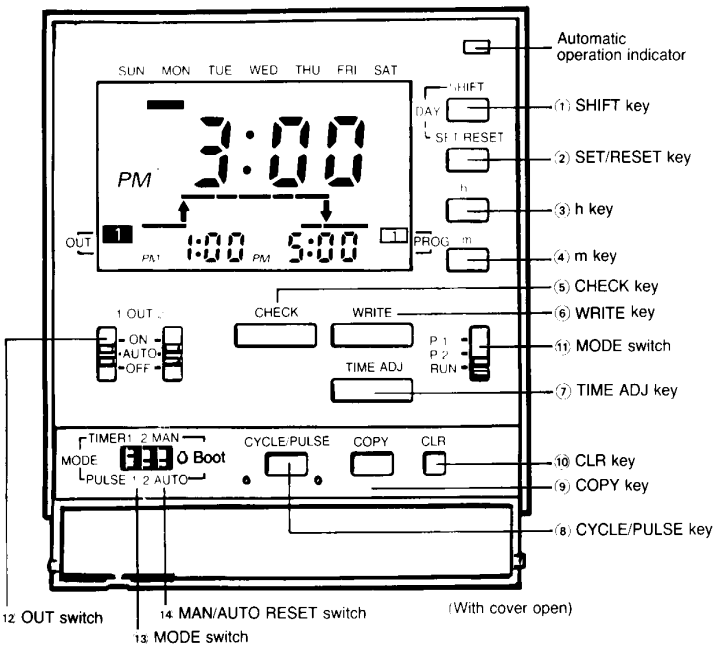
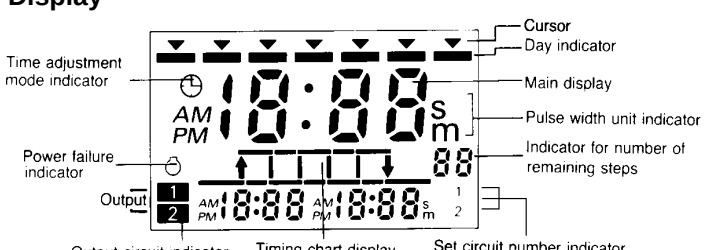
Operation

■ NOMENCLATURE

Front Panel with Cover Open



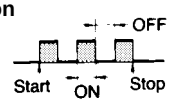
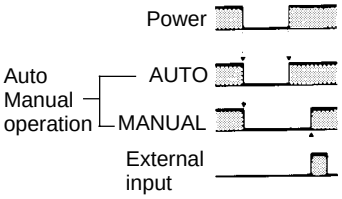
Display



Key Operations

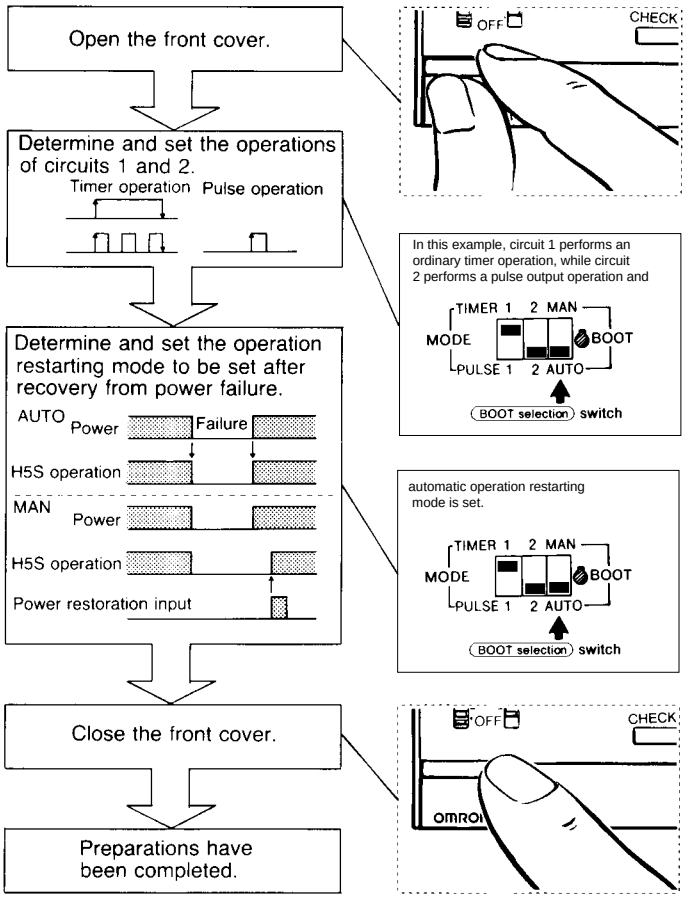
No.	Function
①	Shifts the cursor (▼) specifying a day to the right.
②	Sets or cancels a specified day.
③ ④	Sets a time or ON/OFF time width.
⑤	Monitors the parameters set for an operation during an operation.
⑥	Sets parameters.
⑦	Sets a time adjustment mode.
⑧	Specifies a cyclic operation, or sets a pulse width.
⑨	Specifies a day substitution operation.
⑩	Cancels the parameters set for each circuit, or a day substitution operation.
⑪	P1: Circuit 1 programming mode P2: Circuit 2 programming mode RUN: RUN mode
⑫	ON: Turns on the output regardless of the program. AUTO: Executes according to the program. OFF: Turns off the output regardless of the program.
⑬	TIMER: Executes an ordinary timer or cyclic operation. PULSE: Executes a pulse-output operation.
⑭	Specifies automatic or manual operation following a power failure.

■ OPERATING FUNCTIONS

Timer Operation 	Controls the output according to the set time of ON and OFF (the time can be set in units of 1 minute)
Pulse-0utput operation 	Produces the output for a fixed duration at the set ON (pulse width: 1 to 59 seconds, or 1 minute to 59 minutes). The pulse width can be set in units of 1 second or 1 minute.
Cycle operation 	Repeatedly performs an ON/OFF operation during a specific period, which can be set in units of 1 minute
Forced ON/OFF operation	Forcibly turns ON/OFF the output by a slide switch
Operation on power restoration 	AUTO: Operation is automatically started on power recovery MANUAL: Operation is started by applying an external no-voltage signal of 0.2 sec minimum after power recovery. Note that the signal must be a low to high transition (open to closed switching).
Day override operation	Executes a day's operation on another day. The specified new operation is performed only for one week. This could be used for holidays.

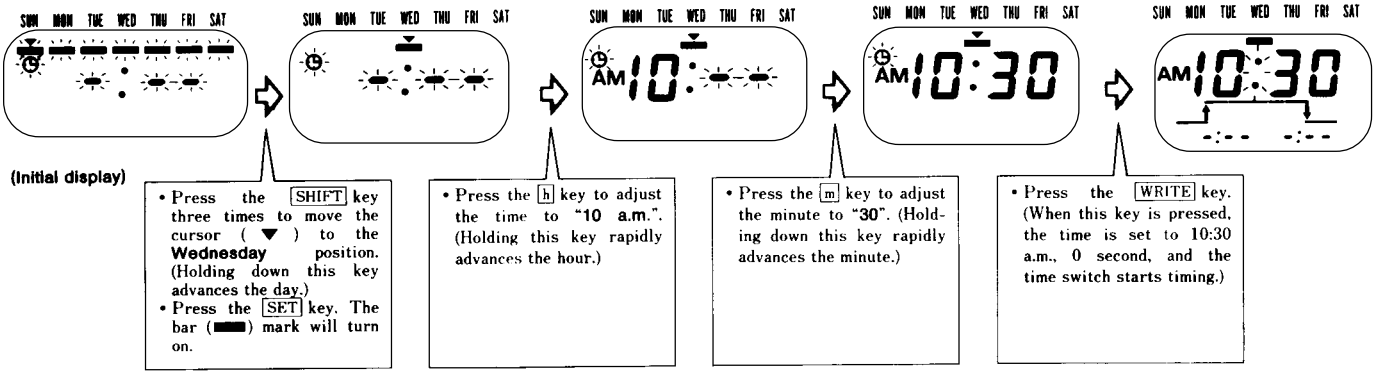
■ PROGRAMMING

Before setting the parameters necessary for each operation, the operation of circuits (outputs 1 and 2) must be determined. Also, specify whether the operation is restarted automatically or manually after power failure recovery.

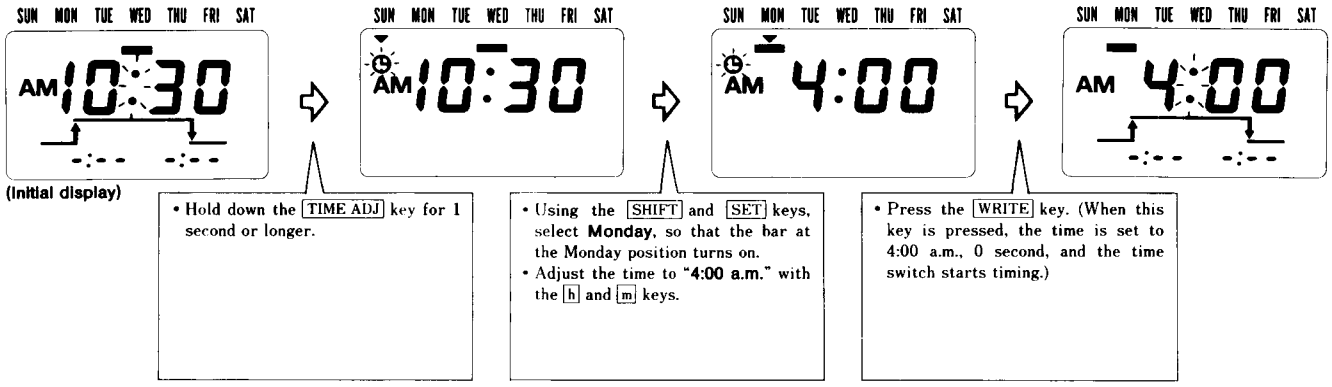


Time Adjustment

The following figures show how to set the time to 10:30 a.m., Wednesday. Mode selector switch should be in RUN position.

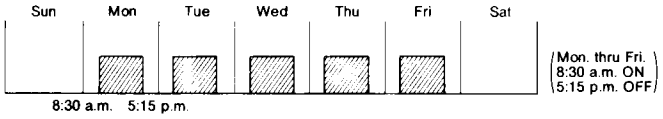


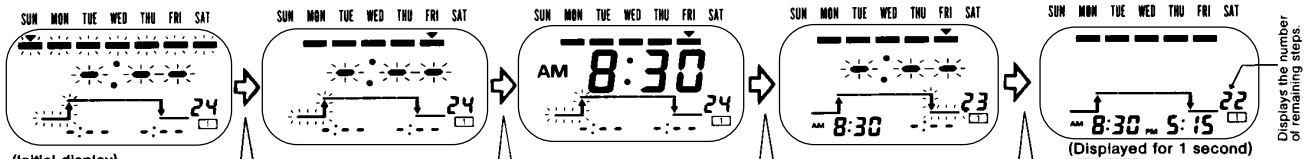
The time and day can also be adjusted or changed while the timer is operating. In the following example, the current set time, 10:30 a.m., Wednesday, is changed to 4:00 a.m., Monday.



Ordinary Timer Operation

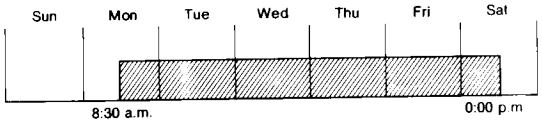
In this example, circuit 1 is set to operate at 8:30 a.m. and stop at 5:15 p.m., from Monday through Friday. Set mode switch to P1.

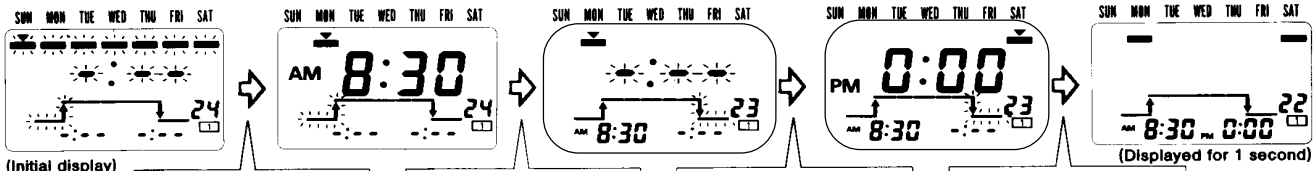




Multiple-Day Operation

The timer turns ON circuit 1 at 8:30 a.m. on Monday, and turns it OFF at 0:00 p.m. on Saturday. Set mode selector to P1.





Number of steps: 2

- Select **Monday** with the SHIFT and SET keys.
- Set the time to "**8:30 a.m.**" with the h and m keys.

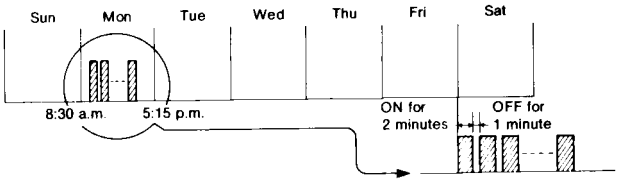
- Press the WRITE key.

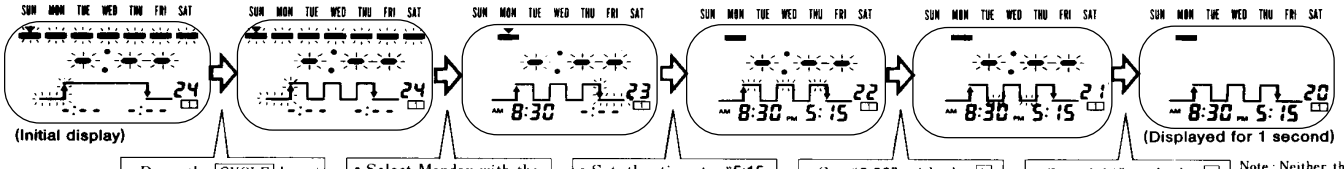
- Cancel **Monday** with the RESET key.
- Select **Saturday** with the SHIFT and SET keys.
- Set the time to "**0:00 p.m.**" with the h and m keys.

- Press the WRITE key.

Cycle Operation

Circuit 1 is set to turn ON for 2 minutes and OFF for 1 minute repeatedly, from 8:30 a.m. to 5:15 p.m. on Monday. Set mode selector to P1.





Number of steps: 4

- Press the CYCLE key.

- Select Monday with the SHIFT and SET keys.
- Set the time to "**8:30 a.m.**" with the h and m keys.
- Press the WRITE key.

- Set the time to "**5:15 p.m.**" with the h and m keys.
- Press the WRITE key.

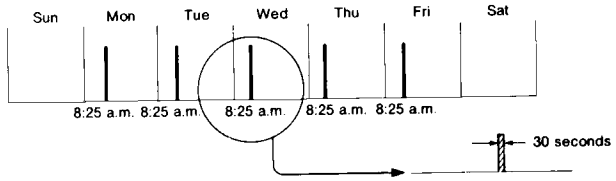
- Set "**0:02**" with the h and m keys.
- Press the WRITE key.

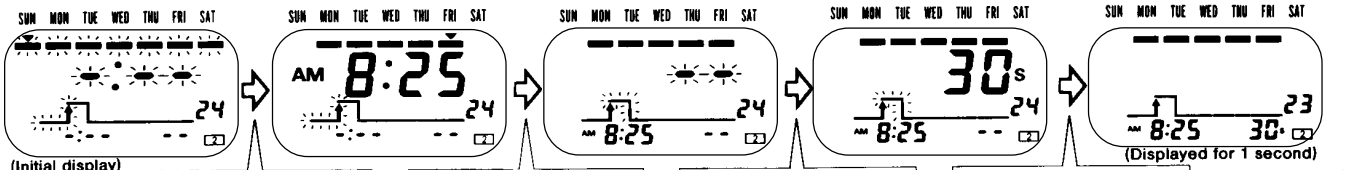
- Set "**0:01**" with the h and m keys.
- Press the WRITE key.

Note: Neither the ON nor the OFF time can be set to "0:00".

Pulse Output Operation

Circuit 2 is turned ON for 30 seconds at 8:25 a.m., Monday through Friday. Set mode selector to P2.





Number of steps: 1

- Select **Monday** through **Friday** with the SHIFT and SET keys.
- Set the time to "**8:25 a.m.**" with the h and m keys.

- Press the WRITE key.

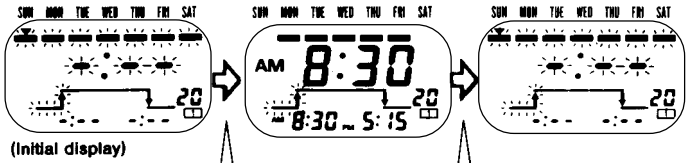
- Press the PULSE key to set "**30s**". (Holding down this key rapidly advances the second.)

- Press the WRITE key.

Note: If the pulse width (i.e., the second) was set previously, that pulse width is displayed.

Checking the Set Time

The set times can be checked and, if necessary, changed in the sequence they were set. In this example, the times set for circuit 1 are checked. Set mode selector switch to P1.



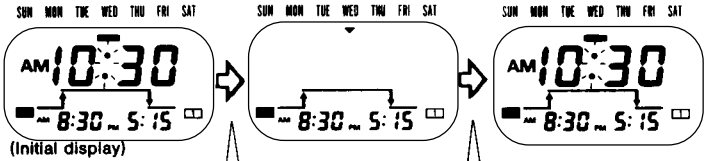
(Initial display)

- Press the WRITE key. If it is necessary to change the setting, do so with the necessary keys and press the WRITE key. (Each time the WRITE key is pressed, the subsequent set times are displayed in the sequence they were set.)

- Press the WRITE key. After all the set times have been displayed, the first set time is displayed again.

Note: When the MODE switch is set to the P1 (or P2) position, the output is turned off. To turn on the output, use the OUT ON/OFF switch.

The set times can be checked in the sequence the timer is to operate. In the following example, the times set for today are checked. Set mode selector switch to RUN.



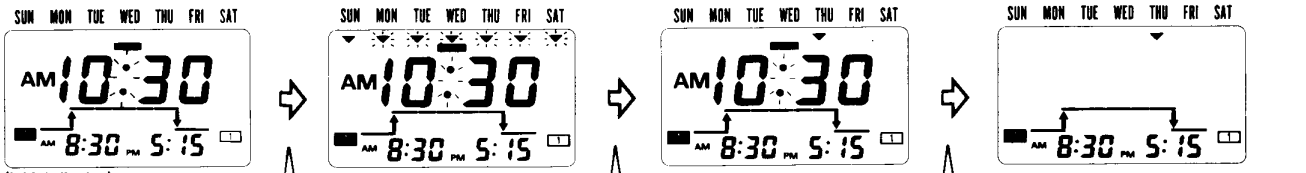
(Initial display)

- Press the CHECK key.
  - Each time this key is pressed, the operation schedule is displayed in the time sequence.
  - First, the ON times and OFF times set for circuit 1 are displayed starting from the earliest ON time. Then the times set for circuit 2 are displayed.

- Press the CHECK key. After all the set times have been displayed, the first set time is displayed again.

Note:
If the time switch is left untouched for 20 seconds during checking, the display automatically returns to the RUN mode. If the timer is set to perform cyclic operation, press the CHECK key twice to check one operation.

It is also possible to check the timing operations in the sequence they are to be executed. The operations to be performed Thursday are checked. Mode selector switch is in RUN.



(Initial display)

- Press the SHIFT key.

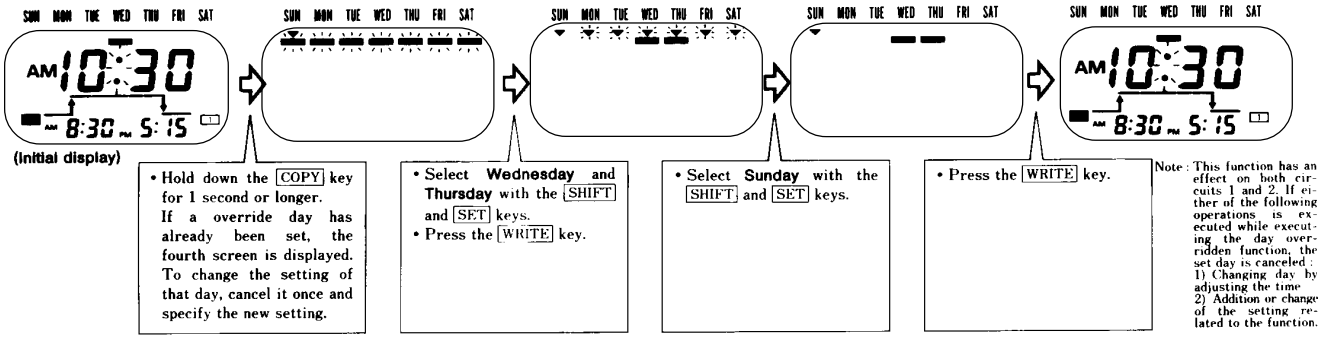
- Press the SHIFT key to stop the blinking of the cursor (▼) at the **Thursday** position.
- Press the SET key.

- Press the CHECK key.
(Each time this key is pressed, the operation schedule is displayed in the sequence the operations are to be executed. The ON times and OFF times set for circuit 1 are first displayed, starting from the earliest ON time. Then the times set for circuit 2 are displayed. After all the set times of both the circuits have been displayed, the time switch enters the RUN state display.)

Note: If the time switch is left untouched for 20 seconds during checking, the display automatically returns to the RUN mode. If the timer is set to perform cyclic operation, press the CHECK key twice to check one operation.

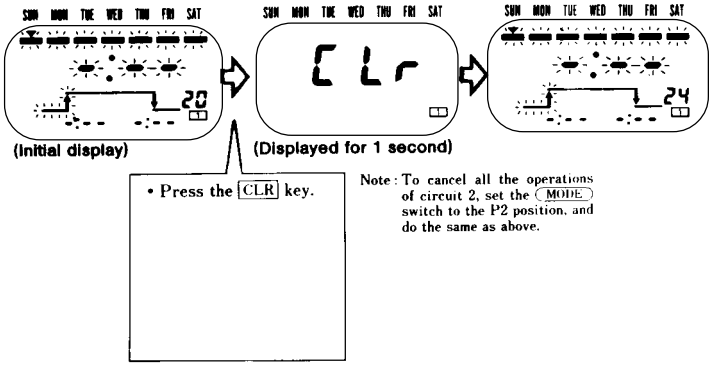
Day Override

Wednesday and Thursday are holidays in the next week, the operations set for Sunday will be executed on these days. (The time switch executes the new program for only one week from the day next to when the program is set. After the one week, the timer operates according to the previous program.)

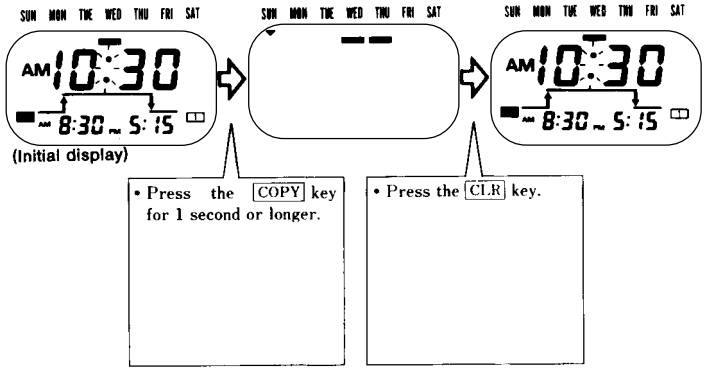


Canceling the Setting

All the operations of circuit 1 or 2 can be cancelled. In the following example, all the operations of circuit 1 are cancelled. Set mode selector switch to P1.



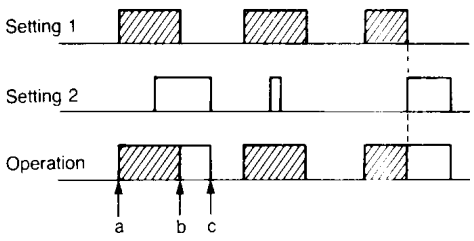
In the next example an overriden operation is cancelled. Set mode selector to RUN.



■ PRECAUTIONS

Ordinary Timer Operation

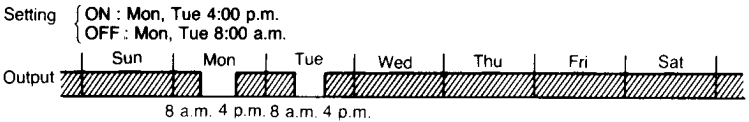
The earlier ON time takes precedence.



If both settings 1 and 2 are for an ON/OFF or pulse operation, the output is continuously produced without being interrupted. For example, if setting 1 is for cyclic operation, and 2 is set for an ON/OFF operation, the cyclic operation is performed during period of a to b, and the ON/OFF operation is performed from b to c.

Multiple-Day Operation

If more than one day is specified and when the output is turned on, it is turned off on the day when the first OFF time is set.



If an ON and an OFF have been set at the same time of the same day (such setting is possible), no operation is performed.

If the MODE switch is set to the P1 (or P2) position, no output is produced. Therefore, after setting has been done, set the MODE switch to the RUN position and confirm that the automatic operation indicator lights.

The set data may be erased if the OUT switch is moved between the TIMER and PULSE positions after the data has been set.

Carver
Creating Value.

OWNER'S MANUAL

for

MART

VERTICAL POWER WASHER PUMP

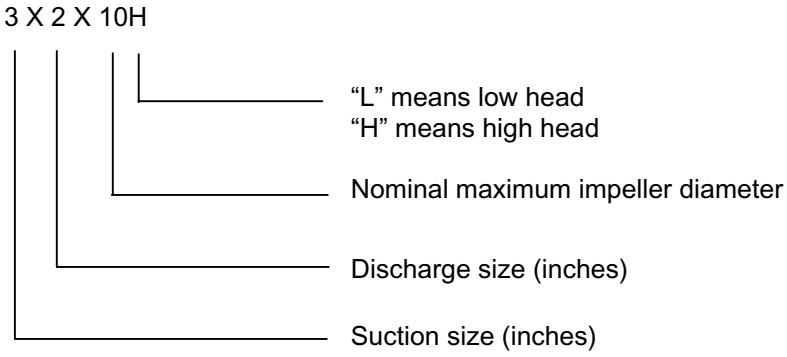
TABLE OF CONTENTS

I. GENERAL DESCRIPTION AND SAFETY PRECAUTIONS.

A. GENERAL DESCRIPTION. The Vertical Pump is designed for the industrial washer application.

The pump is flexible coupled to a constant speed motor. The pump and motor are mounted on a structural steel baseplate. The pump end consists of a casing, shaft, impeller, backhead, suction head, column, baseplate, discharge piping, bearing frame, and bearings. The bearing frame supports the bearings above the solution tank, thereby preventing contamination of the bearings. Bearings are also protected from fluid and vapors by bearing cap and lip seals.

B. PUMP IDENTIFICATION. Use the following example for identifying information about your pump model number.



C. NAMEPLATE. A nameplate is attached to each pump end. The data on the nameplate should be recorded and filed for easy reference. Nameplate data should be furnished to Mart Corporation or Carver Pump Company when ordering spare parts or requesting information. Record pump serial number and model number on the lines below.

Pump Serial Number _____

Model Number _____

D. SAFETY PRECAUTIONS. This manual contains descriptions and instructions, which are the result of carefully conducted engineering and research efforts. The manual is designed to provide adequate instructions for the safe and efficient installation, operation, or maintenance of the pump. Failure or neglect to properly install, operate, or maintain the pump may result in personal injury, property damage, or unnecessary damage to the pump.

Observe all caution or danger tags attached to the equipment or included in this manual.

CAUTION

IMPORTANT SAFETY NOTICE

Various federal, state, and local laws and the regulations concerning OSHA affect installation, use, and operation of pumping equipment. Compliance with such laws relating to the proper installation and safe operation of pumping equipment is the responsibility of the equipment owner. All necessary steps should be taken by the owner to assure compliance with such laws before operating the equipment.

II. INSPECTION AND STORAGE.

A. INSPECTION. Upon receipt of the shipment, unpack and inspect the pump, motor assemblies, and individual parts to insure none are missing or damaged. Carefully inspect all boxes and packing material for loose parts before discarding them. Immediately report to the factory and to the transportation company if there are any missing or damaged parts incurred during shipment, and file a “damage and/or lost in shipment” claim with the carrier.

B. STORAGE OF PUMP. If the pumping unit and/or parts is not immediately installed and operated, store the equipment in a clean, dry, well-ventilated place, free from vibrations, moisture, and rapid or wide variations in temperature.

Grease Lubricated Pump. Rotate the shaft for several revolutions at least once per month to coat the bearings with lubricant, retard oxidation and corrosion, and prevent possible false brinelling.

Consider a unit to be in storage when:

1. The pump has been delivered to the job site and is waiting to be installed.
2. The pump has been installed but operation is delayed pending completion of construction.
3. There are long (30 days or more) periods between operating cycles.
4. The plant (or department) is shut down for periods of longer than 30 days.

NOTE

Storage requirements vary depending on climatic environment, length of storage, and equipment. For storage periods of three months or longer, contact a representative from Carver Pump Company for specific instructions. Improper storage will damage equipment and will require non-warranty restoration and/or non-warranty product failures.

III. INSTALLATION.

Personnel who possess general training in the operation and maintenance of centrifugal pumps should install the pump. The pumps should be installed in accordance with good safety and machinery practices. Faulty installation will result in operating troubles and premature wear of parts.

When pump is supplied with coupling, motor, and baseplate, the complete set is assembled at Carver Pump Company. After ascertaining the unit has suffered no damage in transit, the pumping unit can be installed. Proceed as follows:

CAUTION

To lift pumping unit, use a hoist or device with suitable lifting capacity. Do not pick up the complete unit by the motor or pump shaft. The motor alone may be lifted using the motor lifting eyes.

1. Make sure the foundation is level. Bolt base to foundation. Rotate the shaft by hand to verify that the pump rotates freely.
2. Connect piping. Extreme care should be taken when connecting new piping lines to ensure that no foreign matter such as dirt, chips, tools, etc., is in the piping, tank, or return piping as this will cause debris to draw into the pump and cause excessive damage. Any debris caught in the pump passageways will throw the pumping unit out of balance.

CAUTION

Ensure piping does not strain pump. Strain may cause misalignment. To ensure proper alignment, check pump shaft for freedom of rotation.

3. Connect any necessary auxiliary piping and gauge lines.
4. Since the pumping unit is shipped with bearings greased, initial greasing is not necessary unless pumping unit has been in storage for an extended period of time.
5. Turn pump and motor shafts by hand to ensure free rotation.
6. Connect wiring to motor. Due to high voltage required to operate the pumping unit, personnel working with the equipment should be familiar with electrical safety practices and modern methods of resuscitation. Methods of modern resuscitation may be obtained from the Bureau of Medicine and Surgery.
7. Connect electrical power supply to motor.
8. Open system valves, if supplied.

IV. ALIGNMENT.

A flexible coupling connects the pump and motor. The motor bracket aligns the pump and motor.

V. OPERATION.

A. PRE-START CAUTIONS:

1. Before starting or operating the pump, read this entire manual, especially the following instructions.
2. Before starting the pump, rotate shaft by hand to assure all moving parts are free.
3. Before starting the pump, install closed guards around all exposed rotating parts.
4. Observe all caution or danger tags attached to the equipment.
5. Never run pump dry because the close running fits within the pump are liquid lubricated. Dry running may result in pump seizure.
6. If excessive vibration or noise occurs during operation, shut the pump down and consult a representative from Mart Corporation.

B. STARTING THE PUMP. Once system valves have been adjusted to the specified pumping conditions, the pumping unit will operate without operator intervention. If problems occur while starting the pump, refer to Table 1, Troubleshooting.

1. Make sure no one is working on the pumping unit.
2. If the pumping unit has been idle for a period of time, make sure the unit is firmly attached to its foundation.
3. Open valves to pressure gauges in system, if supplied.

CAUTION

Check level of liquid in tank to ensure casing is under liquid level.

4. Jog starter switch on motor to check that direction of rotation is clockwise when viewed from the top looking downward. Direction of rotation must agree with the arrow stamped on the pump frame or base.
5. Start the pumping unit in accordance with the directions on the motor controller.
6. Pumping unit is now in full operation.
7. Check amperage draw of motor and compare to the motor nameplate in order to verify proper operation.

C. STOPPING THE PUMP.

1. Stop the pumping unit in accordance with the directions on the motor controller.
2. If the pump is stopped for overhaul, close pressure gauge valves.
3. The pumping unit is now in the “off” position.

VI. MAINTENANCE.

A. BACKHEAD. The backhead is equipped with a throttle bushing. The inside diameter of the throttle bushing will increase with wear. If the pump is not equipped with a shaft sleeve, the throttle bushing requires replacement if the inside diameter is 1.644 inches or greater. If the pump is equipped with a shaft sleeve, the throttle bushing requires replacement if the inside diameter is 1.905 inches or greater.

B. BEARING TEMPERATURE. Bearing temperature should be monitored periodically. Normal operating temperatures are 120 degrees F to 160 degrees F, depending on the ambient temperature. Bearings may appear to run hot when pump is first started. The lip seal, not the bearing, causes this to happen. When the seal is seated, temperature should drop to normal.

Check bearing temperature by placing a pyrometer against the bearing frame while pump is running. A temperature rise above 180 degrees F indicates possible damage or wear. The most common cause of high bearing temperature is overgreased bearings.

C. BEARING LUBRICATION. Lubrication frequency depends on operating conditions. Normal duty calls for relubrication every 1000 hours of operation. Bearings are lubricated at Carver Pump Company with Mobilith Grease AW2, which is a lithium complex soap type grease. Only Mobilith Grease AW2 should be used. On the pump bearing frame, both bearings require grease.

To relubricate bearings, use the following procedure:

CAUTION

Overgreasing creates heat and is the cause of many problems requiring repair. Do NOT overgrease.

1. Never relubricate pump bearings while unit is running. If necessary, shut down pump in accordance with section V, Operation.

CAUTION

Do NOT lubricate bearings with a power grease gun.

2. Using a hand-operated grease gun on grease fittings, add approximately one ounce of fresh grease for each bearing. With most hand-operated grease guns, two or three pumps is enough. Do NOT overgrease. When installing new bearings, pack new bearings only half full with grease.

Bearing temperature may rise above normal immediately after lubrication, but should stabilize within 4 to 8 hours.

VII. TROUBLESHOOTING.

If you have followed the installation and starting procedures outlined in this manual, the pump should provide reliable service and long life. However, if operating problems occur, significant time and expense will be saved if Table 1, Troubleshooting, is used to eliminate the most common causes of those problems.

Table 1. Troubleshooting

Symptom	Probable Cause	Remedy
Failure to deliver liquid.	1. Discharge valve closed. 2. Discharge head above shutoff. 3. Impeller or suction partially clogged. 4. No power. 5. Liquid level in tank too low.	1. Check discharge valve. 2. Call MART Technical Service at 1-800-543-MART 3. Inspect impeller and suction pipe and clean. 4. Check power connection to motor. 5. Add liquid to system.
Reduced capacity and/or pressure.	1. Discharge valve closed. 2. Damaged impeller. 3. Impeller or suction pipe partially clogged. 4. Liquid level in tank too low. 5. Total head too high. 6. Wrong rotation. 7. Speed too low. 8. Discharge piping loose. 9. Worn throttle bushing. 10. Worn swivel joint.	1. Check discharge valve. 2. Replace impeller. 3. Inspect impeller and suction pipe and clean. 4. Add liquid to system. 5. Call MART Technical Service at 1-800-543-MART. 6. Check power connections to motor. 7. Call MART Technical Service at 1-800-543-MART. 8. Check, inspect. 9. Check, inspect. 10. Check, inspect.
Pump surges.	1. Liquid level in tank too low. 2. Solution is too hot. 3. Solution is too viscous.	1. Add liquid to system. 2. Lower solution temperature. 3. Drain and clean machine.
Pump loses prime after starting.	1. Liquid level in tank too low. 2. Solution is too hot.	1. Add liquid to system 2. Lower solution temperature.
Overload on motor.	1. Head lower than that for which pump is designed. 2. Mechanical defects of pump or motor such as bent shaft, binding or rubbing rotating element. 3. Liquid handled of higher specific gravity or lower viscosity than intended application. 4. Excess liquid being pumped. 5. Worn nozzles. 6. Worn throttle bushing. 7. Worn swivel joint.	1. Call MART Technical Service at 1-800-543-MART. 2. Replace defective parts or replace pump or motor. 3. Call MART Technical Service at 1-800-543-MART. 4. Call MART Technical Service at 1-800-543-MART. 5. Check, inspect. 6. Check, inspect. 7. Check, inspect.
Insulation failure.	1. Oil or water soaked windings. 2. Excessive vibration.	1. Disassemble motor, clean and dry windings. 2. Refer to “vibrates or is noisy.”

Table 1. Troubleshooting (cont.)

Symptom	Probable Cause	Remedy
Insulation failure. (cont.)	3. Wrong voltage.	3. Check voltage at motor terminals.
Vibrates or is noisy.	1. Insufficient or insecure foundation.	1. Enlarge foundation or relocate pumping unit so it can be firmly bolted to foundation.
	2. Mechanical defects of pump or motor such as bent shaft, binding rotating element, or warped impeller.	2. Replace defective parts or replace pump or motor.
	3. Foreign matter in pump impeller.	3. Disassemble pump. Clean and replace damaged parts.
	4. Strain due to piping or improper piping supports.	4. Check piping alignment and remove piping weight from pump with proper supports.
	5. Misalignment.	5. Align pump and motor as outlined in section IV of this manual.
	6. Damaged bearings.	6. Replace bearings.
	7. Throttle bushing is worn.	7. Replace throttle bushing.
	8. Impeller loose.	8. Disassemble pump in accordance with section VIII. Inspect parts and replace damaged parts.
	9. Cavitation.	9. Disassemble pump in accordance with section VIII. Clean pump and replace damaged parts.
Rapid wear of coupling spider.	1. Misalignment.	1. Align pump and motor as outlined in section IV, Alignment.
	2. Bent shaft.	2. Replace shaft.

VIII. DISASSEMBLY AND REASSEMBLY.

After extended operation, it may be difficult to separate some components. Rust solvent may be used and suitable extricating tools where possible. Use hammers with plastic or rubber heads; hammers with metal heads can damage the pump. Hoisting equipment should be used for lifting heavy parts. It is recommended that safety shoes and safety glasses be worn while working on this equipment.

A. DISASSEMBLY. During disassembly, match mark parts so they can be replaced in their original position.

1. Disconnect, lock out, and tag electrical power supply to motor. Disconnect motor wiring at motor starter.
2. As necessary, flush pump to remove corrosive or toxic liquids.
3. Disconnect discharge piping.

CAUTION

To lift pumping unit, use a hoist or device with suitable lifting capacity. Do not pick up the complete unit by the motor or pump shaft. The motor alone may be lifted using the motor lifting eyes.

4. Remove hex bolts, nuts, and washers securing guard plates to intermediate (61). Remove guard plates.
5. Disconnect coupling (70).

CAUTION

Use a hoist or suitable lifting device with adequate lifting capacity to lift motor and intermediate.

6. Remove bolts (65) attaching motor. Remove motor.
7. Remove nuts, washer, and mounting bolts from the pump mounting plate. Lift the pump and mounting plate out of the tank and place in a suitable work area.
8. Remove nuts (64) and capscrews (63) securing intermediate (61) to bearing frame (30). Remove intermediate (61).
9. Remove capscrews (10) and washers (38) securing suction head (3) to casing (2). Remove suction head (3). Remove suction head gasket (5).
10. Remove impeller jam nuts (A5) and impeller washer (A1). (The first nut is the retaining nut and the second nut is the jam nut).
11. Remove impeller (1) from end of shaft (33) using two pry bars or remove capscrews (35) and washers (37) from backhead (6) and tap backhead (6) gently to drive impeller (1) off shaft (33). Remove impeller key (A2).

NOTE

If necessary, a hoist may be attached to casing (2) by removing pipe plugs (11) from casing (2) and inserting lifting eyes into pipe plug holes.

12. Remove capscrews (10) and washers (38) securing backhead (6) to casing (2). Remove casing (2) from pumping unit.
13. If not removed in step 10, remove capscrews (35) and washers (37) securing column (31) to backhead (6). Remove backhead (6). Remove backhead o-ring (G16).
14. Remove shaft sleeve (34), if equipped.

NOTE

If throttle bushing (B3) is metal, locking ring (B1), capscrews (B4), and setscrews (B5) are not required.

15. If throttle bushing (B3) needs to be replaced and if equipped, remove capscrews (B4) securing locking ring (B1) to backhead (6). Remove locking ring (B1), if equipped with throttle bushing (B3) from backhead (6). If equipped with locking ring (B1), remove setscrews (B5) and separate throttle bushing (B3) from locking ring (B1).
16. Loosen, but do not remove, setscrews (B6) in slinger (B2). Remove slinger (B2).
17. Remove capscrews (G9) securing bearing cap (G1) to bearing frame (30).
18. Pull shaft (33) from inboard side (coupling side/top side) of pumping unit.
19. Using a puller, remove coupling hub (70) from shaft (33). Remove coupling key (G11).
20. Remove bearing cap (G1) from shaft (33).
21. Uncrimp bearing lockwasher (G13). Removing bearing locknut (G4) and bearing lockwasher (G13).
22. Using a puller, remove radial bearing (G3) and thrust bearing (G2) from shaft (33).
23. Remove lip seals (G5) from ring (71) and bearing frame (30). Remove lip seal (G6) from bearing cap (G1).

B. PARTS INSPECTION.

1. After disassembly, all parts should be thoroughly cleaned and inspected. Damaged or worn parts should be replaced with new ones. All sealing faces should be perfectly clean. It is recommended that lip seals, bearings, gaskets, o-rings, and locking devices with a nylock feature be replaced with new.
2. Inspect inside diameter of the throttle bushing (B3). The inside diameter of the throttle bushing (B3) will increase with wear. If the pump is not equipped with a shaft sleeve, the throttle bushing requires replacement if the inside diameter is 1.644 inches or greater. If the pump is equipped with a shaft sleeve, the throttle bushing requires replacement if the inside diameter is 1.905 inches or greater.
3. If pump is not equipped with shaft sleeve, inspect the shaft diameter. If the shaft diameter is 1.605 inches or less, replace the shaft. If the pump is equipped with shaft sleeve, inspect outside diameter of sleeve. If shaft sleeve outside diameter is 1.855 inches or less, replace shaft sleeve.
4. On the impeller, check the clearance as follows:
   a. Measure outside diameter of impeller (1) eve wear surface in three places.
   b. Measure inside diameter of suction head (3) wear surface in three places.
   c. If difference between high reading of inside diameter of the suction head (3) and low reading of outside diameter of impeller (1) wear surface exceeds double the maximum clearances given in Table 2, replace suction head (3) and impeller (1).

C. REASSEMBLY OF PUMP. During reassembly, return parts to their original position. Tighten nuts and bolts to the values listed in Table 4, Recommended Torque Values.

1. Install new lip seals (G5) in ring (71) and bearing frame (30). Install new lip seals (G6) in bearing cap (G1).
2. Pack new bearings half full with Mobilith Grease AW2. Press new radial bearing (G3) on shaft 933). Press thrust bearing (G2) in bearing cartridge (G12).
3. Install bearing lockwasher (G13). Install and tighten bearing locknut (G4). Recrimp bearing lockwasher (G13).
4. Install bearing cap (G1) and secure with capscrews (G9).
5. Install coupling key (G11). Install coupling hub.
6. Install shaft (33) through bearing frame (30).

CAUTION

Take special care to avoid damaging seals. If seals are damaged, replace with new seals.

7. Install slinger (B2) on shaft (33) and secure with setscrews (B6).
8. If throttle bushing (B3) was removed, press new throttle bushing (B3) into backhead with a hydraulic press until the throttle bushing (B3) and stuffing box are flush.

Table 2. Enclosed Impeller Clearance

Model (Suction x Discharge x Maximum Impeller Diameter)	FACTORY STANDARD DIAMETRIC CLEARANCE	
	Minimum	Maximum
3 x 2 x 10H	0.012	0.017
5 x 4 x 11	0.016	0.021

9. Install locking ring (B1), if equipped, and use a ¼-20 NC-2 tap to tap drill through setscrew (B5) holes and tap throttle bushing (B3).
10. If equipped with locking ring (B1), insert setscrews (B5) through locking ring (B1) and throttle bushing (B3).
11. Install shaft sleeve (34), if equipped.

12. Install new backhead o-ring (G16) on backhead (6). Install backhead (6) on column (31) and secure with capscrews (35) and washers (37).

NOTE

If necessary, a hoist may be attached to lifting eyes on casing, which were used during disassembly.

13. Install casing (2) and secure to backhead (6) with washers (38) and capscrews (10).
14. Install impeller key (A2). Install impeller (1) and secure with impeller washer (A1), impeller stud (A3), and two impeller jam nuts (A5). Hold coupling and tighten the first jam nut. Then install and tighten the second jam nut.
15. Install new suction head gasket (5) on suction head (3). Install suction head (3) and secure to casing (2) with lock washers (38) and capscrews (10).
16. Remove lifting eyes from casing (2). Install pipe plugs (11).

CAUTION

Use a hoist or suitable lifting device with adequate lifting capacity to lift motor and intermediate.

17. Install pumping unit into tank. Secure base to tank with lockwashers, nuts and capscrews.
18. Install intermediate (61) and motor on pumping unit. Secure intermediate (61) to bearing frame (30) with nuts (64) on capscrews (63).
19. Reconnect coupling.
20. Install guard plates and secure to intermediate (61) with capscrews and washers.

CAUTION

To lift pumping unit, use a hoist or device with suitable lifting capacity. Do not pick up the complete unit by the motor or pump shaft. The motor alone may be lifted using the motor lifting eyes.

21. Reconnect discharge piping.

CAUTION

Ensure piping does not strain pump. Strain may cause misalignment. To ensure proper alignment, check pump shaft for freedom of rotation.

22. Install motor and coupling.
23. Reconnect wiring to motor. Reconnect electrical power supply to motor. Fill tank with water and start pump.
24. Open all system valves.
25. Rotate pump by hand to ensure there is no binding or rubbing.

IX. PARTS LIST.

A. PARTS ORDERING. When ordering parts, prompt accurate service will be provided if you inform Mart Corporation of the following information.

1. Serial number of pump (located on nameplate).
2. Part description (located on parts list).
3. Part number (located on parts list).
4. Quantity of parts needed.

For replacement parts contact:

MART Corporation
2450 Adie Road
Maryland Heights, MO, 63043
www.martwash.com

Toll-free: 800-543-6278
Switchboard: 314-567-7222
Fax: 314-567-6551
Email: themart@martwash.com (ATTN: SERVICE)

If motor or motor parts are ordered, specify name of manufacturer and all other data on driver nameplate.

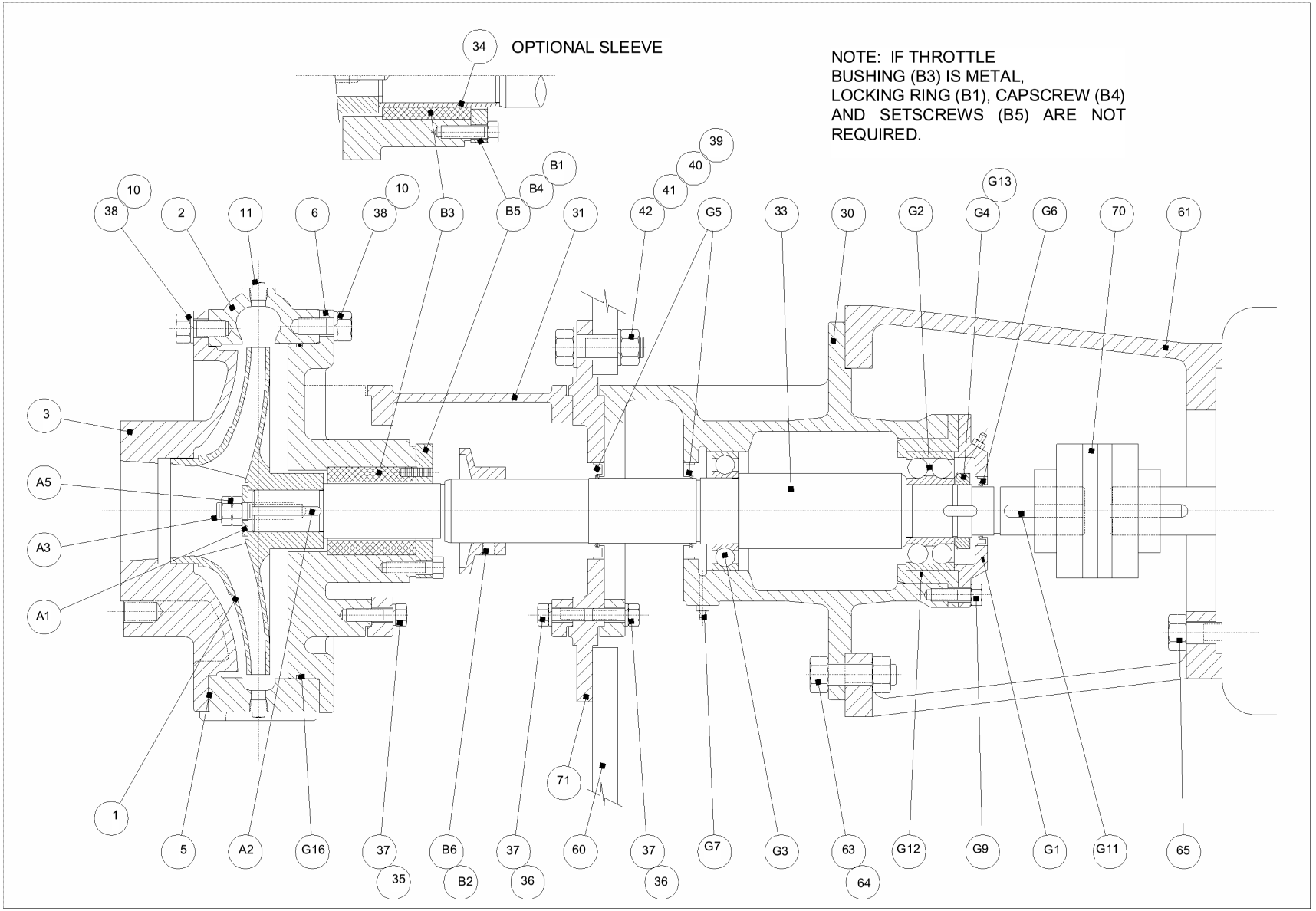
Below is a general vertical pump parts list, Table 3. The vertical pump sectional assembly drawing (located toward the back of this manual) shows the location of parts listed in Table 3.

Table 3. Parts List

PART #	PART DESCRIPTION	PART #	PART DESCRIPTION
1	Impeller	70	Coupling
2	Casing	71	Ring
3	Suction head	A1 – "A" Kit	Impeller washer
4	Gasket (suction head)	A2 – "A" Kit	Impeller key
6	Backhead	A3 – "A" Kit	Impeller stud
10	Capscrew (suction head-casing and backhead-casing)	A5 – "A" Kit	Impeller jam nut
11	Plug (casing)	B1 – "B" Kit	Locking ring (required if throttle bushing is metal)
30	Bearing frame	B2 – "B" Kit	Slinger
31	Column	B3 – "B" Kit	Throttle bushing
33	Shaft	B4 – "B" Kit	Capscrew (locking ring-backhead, required if throttle bushing is metal)
34	Shaft sleeve (optional)	B5 – "B" Kit	Setscrew (locking ring-bushing, required if throttle bushing is metal)
35	Capscrew (column-backhead)	B6 – "B" Kit	Setscrew (slinger)
36	Capscrew (frame-column)	G1	Bearing cap
37	Lockwasher (column-backhead, column-base)	G2	Thrust bearing
38	Lockwasher (suction head-casing, backhead-casing)	G3	Radial bearing
39	Capscrew (column-base)	G4	Bearing locknut
40	Hex nut (column-base)	G5	Lip seal (bearing frame, column)
41	Washer (column-base)	G6	Lip seal (bearing cap)
42	Lockwasher (column-base)	G7	Grease zerk
60	Baseplate	G9	Hex head bolt (bearing cap-frame)
61	Intermediate	G10	Plug
63	Hex head bolt (frame-intermediate)	G11	Coupling key
64	Hex nut (frame-intermediate)	G12	Bearing cartridge
65	Hex head bolt (motor-intermediate)	G13	Bearing lockwasher
		G16	O-ring

Table 4. Recommended Torque Values

Bolt Size	Material	
	Steel (or otherwise noted)	316 Stainless Steel
¼”-20	5	7
5/16”-18	11	12
3/8”-16	18	21
½”-13	39	45
5/8”-11	83	97
¾”-10	105	132
7/8”-9	160	203
1”-8	236	300



Vertical Pump Sectional Assembly Drawing