
**MotorVac Technologies,
Inc.**

MCS 400

SERVICE MANUAL

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INTRODUCTION

GENERAL

The MotorVac CarbonClean System is a very reliable product designed to perform many years of service. Because of the environment in which the MCS 400 operates, safety dictates that all MCS 400 system problems be repaired quickly and correctly. This service manual describes how to operate, maintain and repair the MCS 400.

Please study the Operator, Service and Maintenance Procedures to become thoroughly familiar with the MCS 400 before attempting any repairs.

SAFETY INFORMATION AND PRECAUTIONS

1. vehicle exhaust gases contain Carbon Monoxide, which is a colorless and odorless lethal gas.
 - a. Only run engines in well-ventilated areas and avoid breathing exhaust gases.
 - b. Extended breathing of exhaust gases will cause serious injury or death.
2. Exhaust gases, moving parts, hot surfaces, and potent chemicals are present during the use of the fuel system cleaner.
 - a. Read and understand the Operator's Manual before using the fuel system cleaner.
 - b. When using chemicals, always refer to the MSDS sheets and manufacturer's instructions for the proper procedure to handle emergency medical treatment, cleanup, handling, and storage requirements.
 - c. Improper use of the fuel system cleaner or exposure to exhaust gases or cleaning chemicals can cause injury.
3. Flammable fuel chemical and vapors can ignite.
 - a. Avoid exposure to flames, sparks, hot engine parts, and other ignition sources. Always keep a fully charged fire extinguisher nearby. The extinguisher should have a class B rating and be suitable for gasoline, chemical, and electrical fires.
 - b. Clean up any fuel or chemical spills immediately.
 - c. Dispose of contaminated clean-up material according to governing environmental laws.
 - d. Never look directly into the air induction plenum or carburetor throat when the engine is operating. Always plug or cap any open fuel lines during service.
 - e. Keep cleaner and detergent container closed except when filling reservoir.
 - f. Explosion or flame, or exposure to flammable liquid and vapors can cause injury.

4. Flammable liquid can splash out of the reservoir when the pump is on and/or the unit is being moved.

- a. Always keep the reservoir cap secure except when filling the reservoir.
- b. Explosion or flame can cause injury.

5. Many fuel systems maintain residual pressure in fuel lines even after the engine has been turned off.

- a. Wear safety goggles.
- b. Wear chemical resistant gloves when connecting or disconnecting fittings and adapters.
- c. Obtain ZERO PSI before connecting or disconnecting fuel lines or adapters.
- d. Explosion or flame, or exposure to flammable liquid and vapors can cause injury

6. Chemicals can cause harmful byproducts.

- a. Use only approved chemicals (refer to Operator's Manual).
- b. Do not swallow or ingest chemicals.
- c. Use with adequate ventilation. Avoid breathing vapors.
- d. Do not store chemicals on the machine.
- e. Improper use of chemicals can cause injury.
- f. Over exposure can have a harmful effect on eyes, skin, respiratory system, and possible unconsciousness and asphyxiation can occur.

7. Improperly blocked vehicles can move.

- a. Set the parking brake and chock the wheels.
- b. Moving vehicles can cause injury.

8. Moving engine parts.

- a. The engine cooling fan will cycle on and off depending on the coolant temperature, and could operate without the engine running.
- b. Wear safety goggles.
- c. Always keep objects, clothing, and hands away from the cooling fans and engine parts.
- d. Moving engine parts can cause injury.

9. Hot surfaces are present during and after running the engine.
 - a. Do not contact hot surfaces such as manifolds, pipes, mufflers, catalytic converters, or radiators and hoses.
 - b. Hot surfaces can cause injury.
10. Catalytic converters become extremely hot.
 - a. Do not park a converter-equipped vehicle over dry grass, leaves, paper, or any other flammable material. Do not touch a catalytic converter until the engine has been off for at least 45 minutes.
 - b. For test allowing unburned hydrocarbons, or service involving operation of an overly rich condition, minimize the time of rich operation, monitor the catalytic converter temperature, and allow at least two minutes of operation at normal mixture subsequent to testing or service for converter cooling.
 - c. Catalytic converters can cause burns.
11. A cracked fan blade can become airborne.
 - a. Examine fan blades for cracks. If found, do not service the vehicle.
 - b. Flying objects can cause injury.
12. Batteries produce explosive gases and can explode.
 - a. Wear safety goggles when working on or near batteries.
 - b. Use in a well-ventilated area.
 - c. Keep sparks and flames away from the battery and never lay tools, equipment, or other conductive objects on the battery.
 - d. When tools or equipment are connected to the battery, make sure that the equipment power switch is off. Connect the positive lead of the equipment to the positive lead battery first; connect the negative lead of the equipment to a solid ground point as far from the battery as possible.
 - e. Keep battery acid away from skin or eyes. In case of eye contact, flush with clean water for 15 minutes, and get medical attention.
 - f. Battery explosion and ignited gases can cause injury.

OVERVIEW

The MCS 400 is a self-contained electronic-based cleaning system designed to connect to any gasoline engine. Once the unit is connected, it temporarily replaces the regular fuel supply with a mixture of gasoline and the specifically formulated MotorVac CarbonClean detergent.

With the engine idling, the unit pumps the gasoline/detergent mixture through the engine's fuel system. As the mixture passes through the vehicle fuel system, it loosens and dissolves accumulated deposits which then pass harmlessly out through the vehicle exhaust system or are removed by the unit fuel filter. Removing contaminants from the combustion chamber creates a more even burn of fuel, which in turn improves horsepower and fuel economy, and reduces exhaust emissions.

It is recommended that the fuel system cleaning procedure be performed on a vehicle every 10,000 miles in order to obtain the highest fuel system efficiency.

SYSTEM FEATURES AND FUNCTIONS

The front of the MCS 400 cabinet contains an electronic control panel, the opening for the fuel reservoir, and storage drawers for adapters and other system accessories.

The MCS 400 weighs 85 lbs plus adapters up to approximately 15 lbs.

The MCS operates at, (airborne noise emissions), a level of 69 dB (A)

IMPORTANT

The MCS 400 Fuel System Cleaner Is Designed To Work
EXCLUSIVELY
with the MotorVac CarbonClean detergent.

Use of any other chemical during this process may cause operational failure of the MCS 400 and voids the manufacturer's warranty.
See warranty card for details.

MCS 400 Features And Functions

Descriptions of the gauges, control switches, and status indicators that make up the control panel are listed below. Please become familiar with these control panel features and functions before using the unit.

Adjust Time Knob 1 to 60	Sets or re-sets the system run time in one-minute increments, from minutes.
Start/Run Switch	Starts the cleaning cycle
Run Cycle Light	Illuminates when the run cycle is underway
Fuel Pressure Gauge pressure of	Displays output pressure of the unit's output hose, or system vehicle being serviced.
Pressure Adjust Regulator Turn counterclockwise to open,	Used to adjust the system pressure during the cleaning process. clockwise to close, (increase the pressure); (decrease the pressure).
Vacuum Gauge	Displays vacuum on the vehicle being serviced.
Cycle Complete Light	Illuminates when the run cycle ends.
Warning Alarm occurs.	Beeps when the run cycle is complete or when a pressure loss occurs.
Power Switch	Shuts off power to the unit.
Purge/Fill Switch fuel back the fuel tank of the vehicle	Power: Relieves fuel lines of remaining pressure by transferring into the unit's reservoir. Fill: Transfers fuel from being serviced to the unit's reservoir.
Leak Test Switch	Shuts off pump for the leak test function.
System Warning Light battery expires.	Illuminates when: <ul style="list-style-type: none"> - Polarity is reversed on the connection between the vehicle and the unit. - The fuel/detergent mixture runs out before run time expires. - Vehicle or unit pressure loss is detected.
Output Hose (Red)	Connects to the input side of the vehicle's engine fuel system.
Return Hose (Black)	Connects to the return side of the vehicle's engine fuel system.

Vacuum Hose
engine and

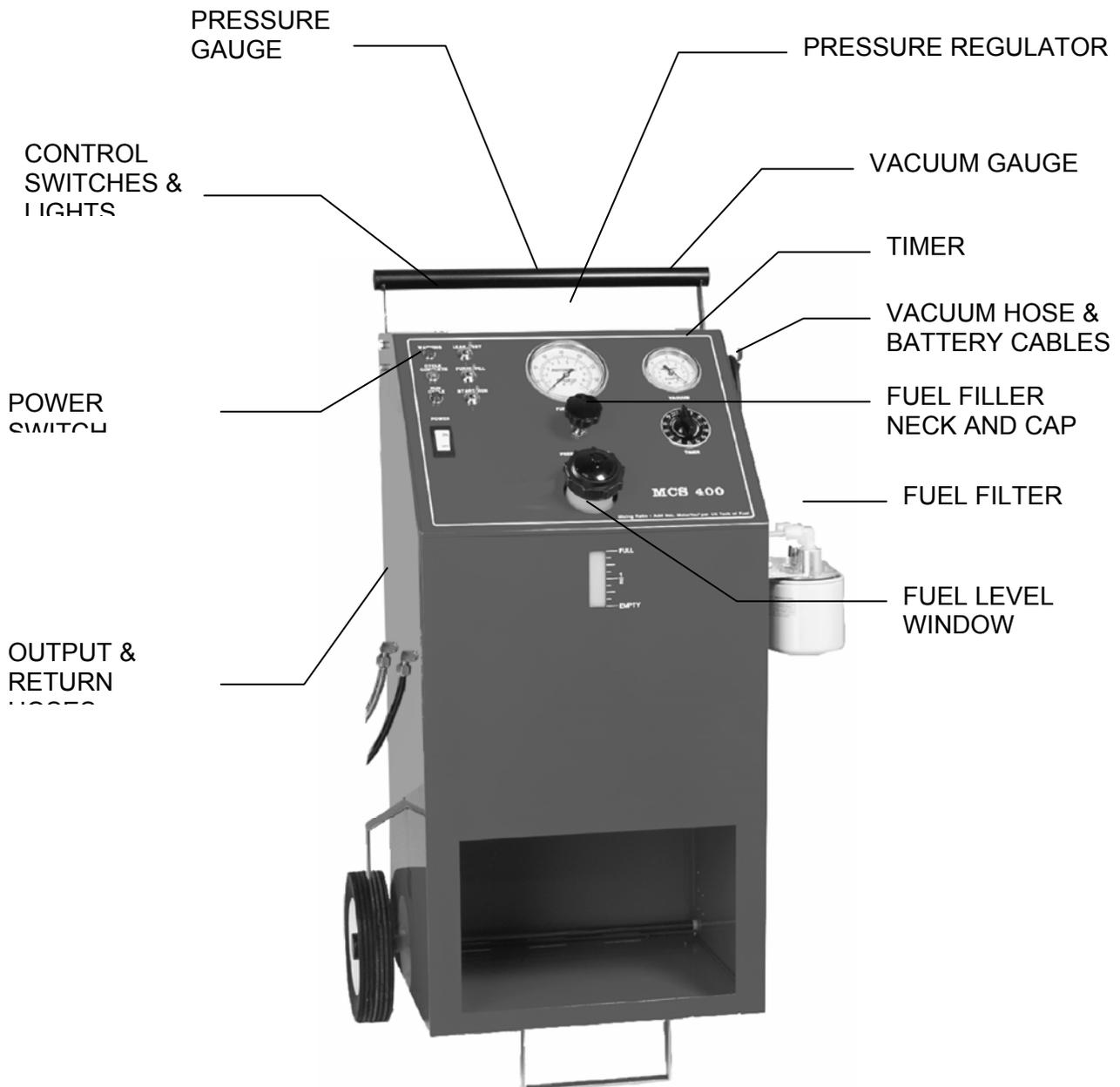
Forms a connection between the vacuum source from the vehicle
the vacuum gauge on the unit.

Fuel Filter
process.

Filters out contaminants that become removed during the cleaning
See **Appendix A** for replacement information.

Battery Cables
VOLTS DC).

Positive (red) and negative (black) battery connections (11-15



TROUBLESHOOTING AND ADDITIONAL HELP

Refer to the list below in the event that problems are found with the MCS 400

Problem	Solution
1. System warning Light Is On And The MCS 400 Is Not Operational	Polarity is reversed on vehicle battery connection. Check Connections for correct polarity.
2. Pressure Gauge On The MCS 400 Displays Maximum Pressure Upon Start Up	Output and return hoses may be reversed. Turn Timer to zero and check hoses for correct connections.
3. Rapid Loss Of Fuel From fuel/detergent The MCS 400 Reservoir	Return hose connection may be incorrect, allowing to return to the vehicle's fuel tank.
4. Start/Run Switch Is On But set Operation Does Not Commence	Check Run/Time. If no time is set, then turn the Time knob to the run time.
5. The MCS 400 Performs dents Poorly been	Check all hoses and wires for cuts or frays. Check cabinet for or impact markings. Verify that the fuel filter has recently replaced.

APPENDIX A - MAINTENANCE

Maintenance Procedures

The following maintenance procedures should be performed on a routine basis:

1. Drain the unit's fuel reservoir and replace the fuel filter after every 30 cleaning services, as described in the next section.
2. Clean the exterior with a non-abrasive cleaning agent or similar product to keep the cabinet looking new. Check the cabinet for dents or impact markings.
3. Check all hoses and wires for cuts or frays.
4. Check internal connections and clean interior of cabinet.
 - a. With a Phillips screwdriver, remove back panel.
 - b. With the back panel removed, visually check inside the unit for obvious problems such as leaks, or wires and fittings that are loose, broken, or disconnected. Repair as necessary.
 - c. Check the sides and bottom of the unit's interior for fluid, dust, or dirt. Carefully wipe liquid or debris from all connections and surfaces with a clean shop cloth to more easily detect less obvious leaks. Repair leaks as necessary.
 - d. Hand check all fittings, hydraulic connections, regulators, solenoids, and connections for tightness. Tighten as necessary.

Replacing The MCS 400 Fuel Filter

The unit's fuel reservoir should be drained and the fuel filter replaced after 30 cleanings to ensure maximum system performance and pump life.

Drain The Fuel Reservoir

1. Turn the **Pressure Adjust** regulator on the control panel counterclockwise until it is completely open.
2. Attach the unit to a motor vehicle battery by connecting the **red** battery clip to the positive (+) battery terminal and connect the **black** battery clip to a solid ground point as far from the battery as possible.
3. Connect the 060-1000 adapter to the output (**red**) hose, then drain the cleaning mixture from the unit's fuel reservoir using the following procedure:
 - Set the **Time** until it displays five minutes.
 - Direct the output (**red**) hose into an appropriate container.

- Press and hold the **Start/Run** switch until the fuel from the unit has been emptied into the container.
- Release the **Start/Run** switch and allow the run time to expire.
- **Dispose of the fuel in an environmentally approved method.**

Replace The Fuel Filter

1. Unscrew the old fuel filter from the filter base on the side of the unit's cabinet.
2. Lightly grease the seal of the new filter and hand tighten it onto the filter base.
3. Add 16 oz. of **MotorVac** detergent to the fuel reservoir and then fill the unit's fuel reservoir with **clean gasoline** until the tank indicates 1/4 tank.
4. Check the filter for leaks.

The unit is now ready for the next cleaning service.

APPENDIX B - LOW PRESSURE CHECK PROCEDURE

Read this procedure thoroughly before starting any repairs. Always use Safety Glasses when working with gasoline or any other petroleum based products.

PRESSURE TEST.

1. Connect battery leads to a well charged battery. (Red = Positive. Black = Negative).
2. No adapters should be connected to output or return hoses for this test.
3. Close pressure regulator completely, (turn clockwise), then back off 1/2 turn.
4. Set timer to 15 minutes. Press Start/Run button to activate pump. Do not release button until a minimum of 10 PSI shows on the pressure gauge.
5. Close the pressure regulator to the end of its travel. Check pressure on the pressure gauge - the pressure should read between 105 and 120 Psi., if not, go to step #6.
6. Remove unit's back panel.
7. With unit running at its maximum pressure, locate the 5/16 nylon hose leading or leaving the pressure regulator. Use a "pinch off tool" (Snap-On part # vp07 - or comparable tool), and carefully crimp off the hose. Notice the pressure reading on the pressure gauge.
8. If Pressure Increases: The pressure regulator is at fault. Replace the regulator. If not, go to step #9.
9. Locate the 5/16 nylon hose connected between the inner right manifold block and the top fitting on the fuel tank, (this is the return hose). Using the tool from step #7, carefully crimp the hose. Notice pressure reading on the pressure gauge.
10. If Pressure Increases: The relief valve needs to be adjusted or replaced, (see Attachment D). If Not, go to the next step.
11. Use a flash light to check all internal hoses for air bubbles. If bubbles are found, check for loose fittings, loose nuts, or kinked/punctured hoses between the bottom fitting of the fuel tank and the fuel pump. repair as necessary.
12. If no bubbles are found, verify 12 volt minimum supply to the pump. Check fuel filter and fuel tank for blockage. If no blockage is found, go to step 13.
13. Verify that there is a 12 volt supply to the solenoid. If not check wire connectors. If voltage is O.K., disassemble the solenoid and check for debris or blockage. Repair as necessary.
14. If all of the above steps check O.K., repeat step #8. If pressure does not increase, replace the fuel pump.

APPENDIX C - PRESSURE SWITCH DIAGNOSTIC PROCEDURE

Follow This Procedure Before Starting Any Repairs.

SYMPTOM: Machine runs only if “Start/Run” switch is activated. Unit stops and “Purges” as soon as the Start/Run switch is released.

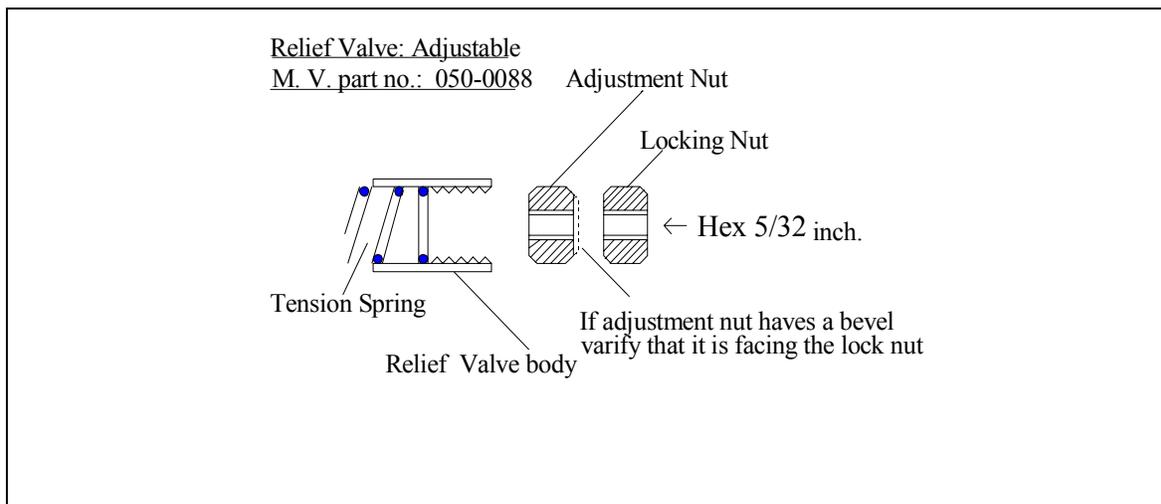
1. Remove unit’s back panel
2. Locate pressure switch, (threaded onto manifold block on the lower right corner of the unit, with white and green wires leading into it).
3. Cut off all fasteners holding white and green wires.
4. Carefully disconnect from P.C. board. Check for burned wires or bad connections, (i.e. crimp of Molex pin to wire). Use a flash light to inspect male Molex pin connection on control board.
5. Check continuity between the green and white wires. There should be NO continuity with the unit’s pump OFF. (NO PRESSURE = NO CONTINUITY).
6. Start unit and increase pressure above 10 Psi. Check for continuity while pressure is above 10 Psi. Continuity should show complete. (PRESSURE = CONTINUITY).
7. If there is NO continuity on pressurized condition, replace pressure switch.
8. If continuity DOES show and connectors are in good condition, replace circuit board.

APPENDIX D - RELIEF VALVE ADJUSTMENT PROCEDURE

1. Disconnect any power to the unit.
2. Remove the return, (black), hose from the elbow fitting and then remove the elbow fitting from the nipple leading into the unit. Be sure to support the elbow fitting when removing the hose and the nipple.
3. Insert the hex tool into the nipple through the block and into the relief valve, loosen the locking nut counter-clockwise, and then push the hex tool into the adjusting nut. Turn both nuts clockwise to increase pressure, (approximately 1/4 turn for 15 Psi). Tighten the locking nut securely after adjustment and then re-install the fitting and return hose. (The 5/32 hex tool needs to be at least 5 inches long).

NOTE: A temporary cap could be used to cap off the nipple while testing the unit for proper pressure setting. (There may be approximately 2 - 10 Psi of fuel pressure).

4. Verify that there are no adapters connected to the output hose. Turn the pressure regulator clockwise to the end of its travel, then back it off 1/2 turn.
5. Start the unit and slowly close the pressure regulator to the end of its travel. pressure should be between 105 Psi and 120 Psi. Repeat the procedure if necessary.



APPENDIX E - SOLENOID DIAGNOSIS AND REPLACEMENT PROCEDURE

Read this procedure thoroughly before starting any repairs. Always use safety glasses when working with gasoline or any other petroleum based products.

Symptom: Unit's pressure gauge loses pressure when in the "Leak Test" mode.

1. Connect output, (red), hose and the return, (black), hose together using adapter #060-4500 and two other adapters that are compatible with each other, (e.g. 060-1000 and 060-1300). Close valve on TEE adapter.
2. Set "Run Time" to 15 minutes. Start unit. Set pressure to 50 Psi. Open valve on TEE adapter briefly to clear air from the output hose. Close valve securely.
3. Close the pressure adjust regulator to the end of its travel. (Maximum pressure should be between 105 and 120 Psi). Let the unit run for five minutes, turn the pressure adjust regulator counter-clockwise, and then set pressure to 50 Psi.
4. Check carefully for fuel leaks from the output hose quick coupler, Fittings connecting output hose to the cabinet, distribution block from inside the unit, the pressure switch, the hose between the block and pressure gauge, connection to pressure gauge, fittings threaded to the solenoid and the solenoid itself, (the seam between the stainless steel base and the electrical coil).
5. Engage the "Leak Test" switch. If the pressure drops, crimp the 5/16 nylon hose leading into the solenoid. If pressure holds, replace the solenoid. If pressure continues to drop, check for leaks again, (repeat steps 3 and 4).

6. SOLENOID REPLACEMENT PROCEDURE

a. Open the valve on the tee adapter completely. Activate the "Purge/Fill" switch until there is no fluid in the hose leading into the solenoid.

b. Disconnect the power supply to the unit's battery leads.

c. Cut off all fasteners holding wires between the solenoid and the control panel. Carefully remove the connector to the P.C. board.

d. Disconnect the hose to the solenoid. Remove the solenoid from the assembly. Remove fittings from defective solenoid and install onto a new solenoid.

NOTE: The solenoid should be installed with the port marked "Out" toward the inside of the unit. (apply Teflon thread sealer on threads before re-installation).

e. Install new solenoid onto assembly. Connect hose. Connect wire to P.C. board.

f. Repeat steps 3 and 4.

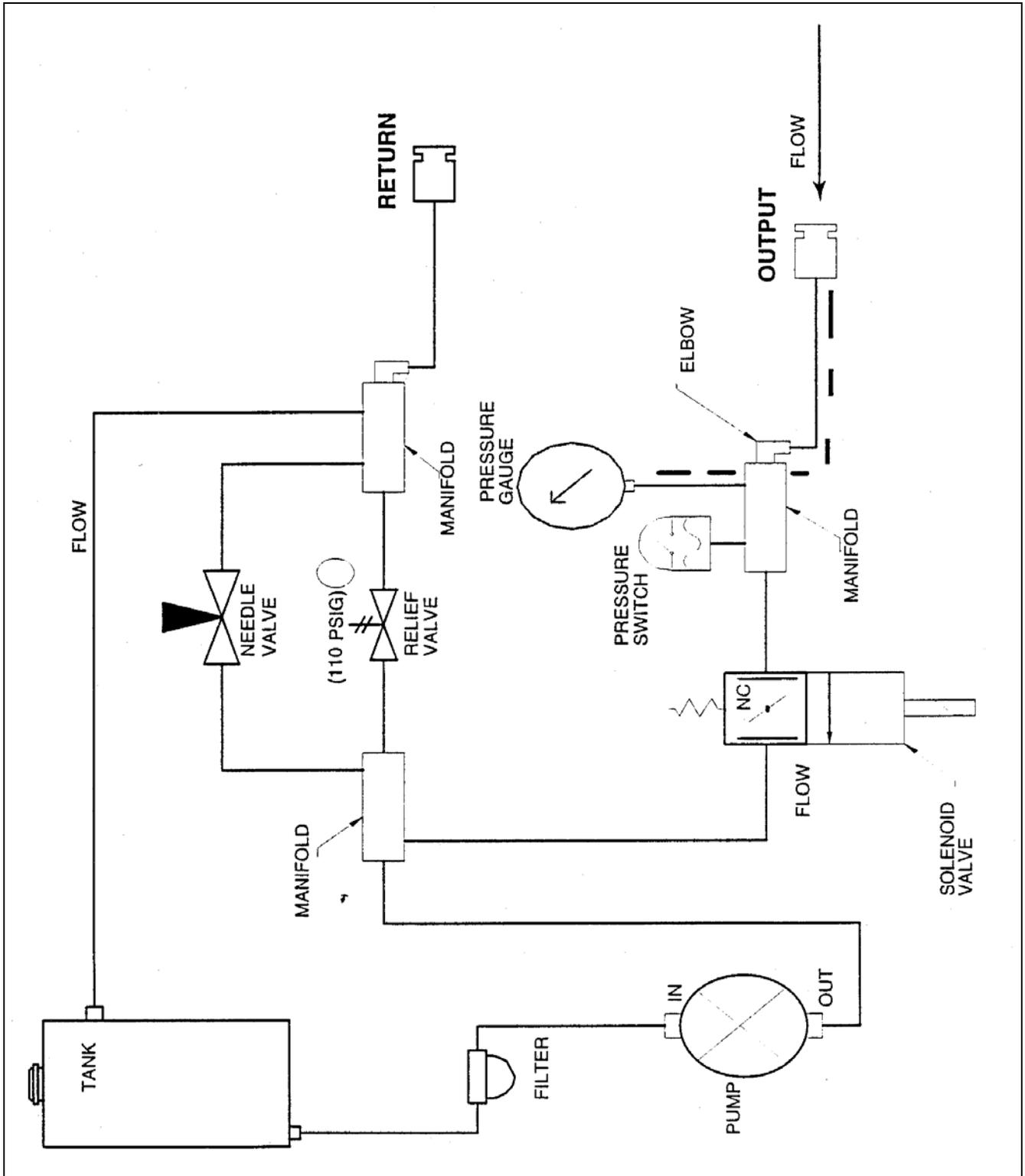
g. Fasten wires. Clean the inside of unit as necessary.

h. Remove adapters and install the unit's back panel.

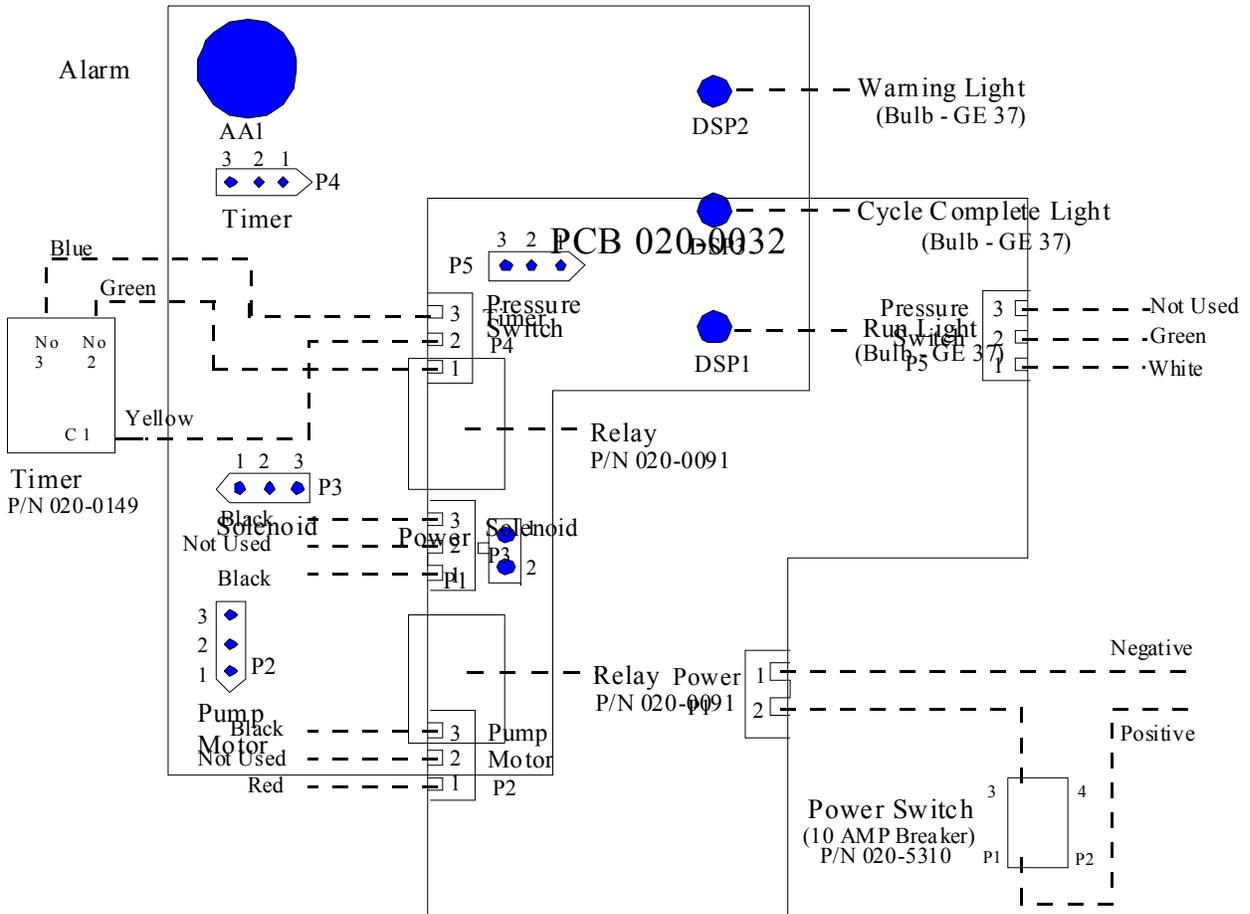
APPENDIX F - SPARE PARTS LIST

Please refer to the part numbers below when ordering parts for the MCS 400

Part #	Description
010-0027	Wheel
010-6018	Drawer, Plastic
010-6060	Reservoir Cap, Vented
030-0020	Connector M. 3/8 x 1/4 NPT NI
050-0005	Gauge, 3.5 inch 0-160 Psi/0-11
050-0007	Pressure Gauge Lens, 3.5 inch.
050-0095	Filter
070-0100	Hose, Vacuum
080-0230	Female Quick Disconnect Couplers
200-0300	ASMB, Return Hose (black)
200-0400	ASMB, Output hose (Red)
050-0006	Gauge Vacuum/Bar 2.5 inch 0-30
050-1910	Gauge Lens vacuum 2.5 inch.
200-7003	Pump ASMB.
200-7008	ASMB, Tank
020-0032	PCB Board
020-0029	Harness-Timer
020-0031	Harness-Power
050-0018	Solenoid 2WNC-SSTEF-12VDC
050-0052	Needle Valve Regulator 1/4 MPT S
050-0088	Relief valve 105 Psi
050-0016	Pressure Switch
010-6017	Front Leg



400 PRINTED CIRCUIT BOARD CONNECTION DIAGRAM



MotorVac Part Number 020-0032

**400
DIAGRAM**

WIRING