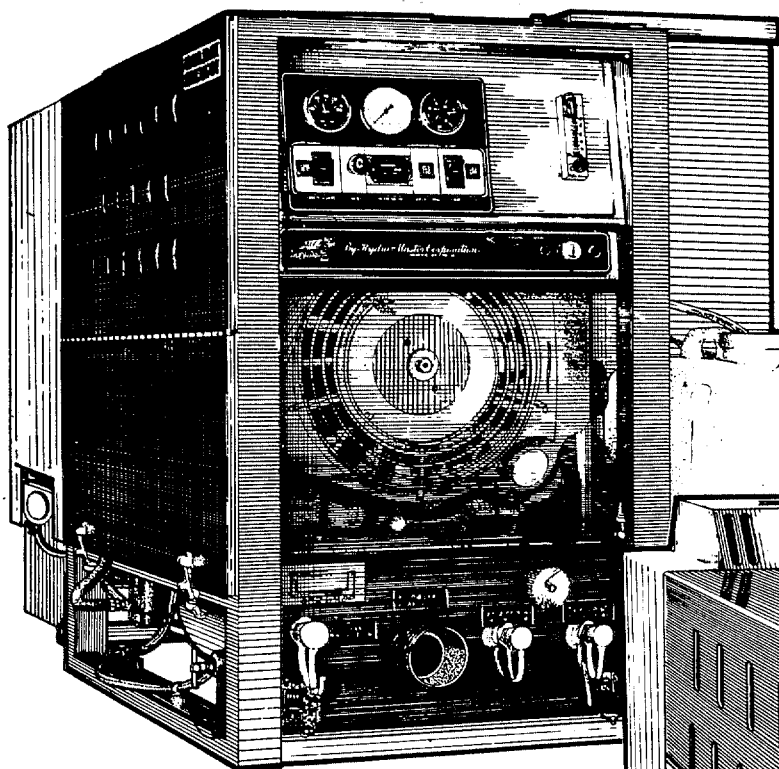




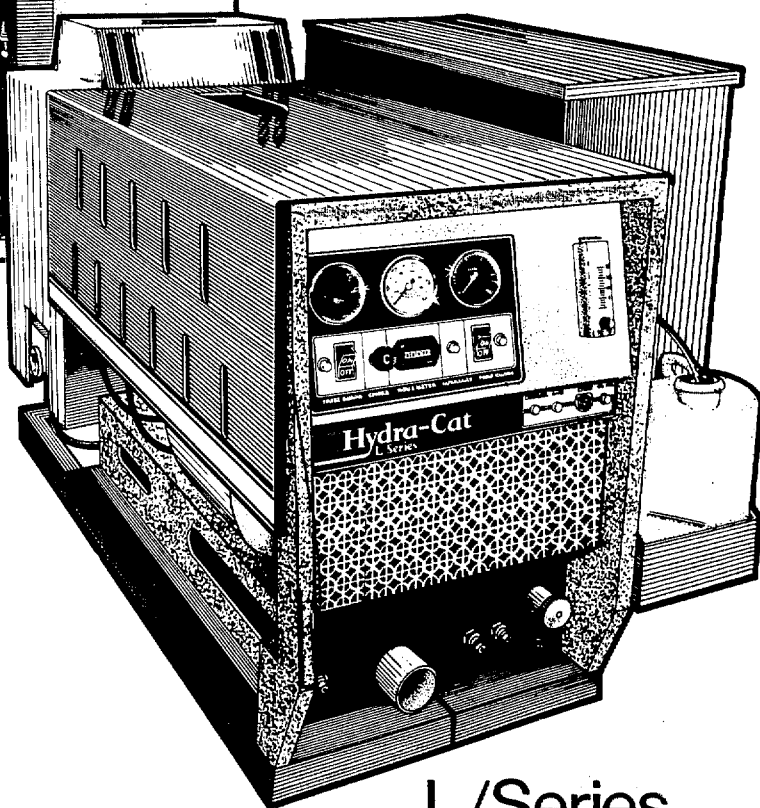
Hydra-Cat

"L" Series & "S" Series

OWNERS MANUAL



S/Series



L/Series

INDEX

	PAGE
General Information	2
Warranty	2
Warranty Information	3
Warranty Procedure	3
Purchaser's Responsibility	4
Truck Preparation Information	4
Truck Preparation Illustration	4
Propane Tank Location/Illustration	5
Hard Water Area Map	5
Machine Specifications	5
Spare Parts Recommendation/Parts Orders	5-6
Water & Chemical Flow Operation	6
Water Flow Diagram	6
Chemical Flow Diagram	6
High Pressure Pump Information	7
Bypass Valve Assembly Illustration	7
High Pressure Pump/Chemical System Troubleshooting	7 & 16
Model 290 Cat Pump Operating Instructions	8-15
Chemical Proportioning and Level Control Illustration	16
Chemical Tank Troubleshooting	16
Heating System Information	16
Heater Operating Instruction	17
Heater Troubleshooting	17
Vacuum System Information	18
Vacuum Flow Diagram	18
Vacuum Tank Filter Bag	18
Vacuum Blower Lubrication (Diagram)	18
Vacuum System Warranty	19
Vacuum System Troubleshooting	20
Engine Manual/Warranty (S/Series)	21-28
Engine Manual/Warranty (L Series)	29-38
Engine Troubleshooting	39
Electrical Diagrams (S/Series & L/Series)	40
Electrical Troubleshooting	40
Machine Installation Information	41
Machine Tie Down Cleat Illustration	41
Propane Hook-Up Illustration	41
Gas Hook-Up Illustration	41
Water Softener Information	42
Jet Assembly	42
Wand Assembly	42
Valve Assembly	42
Machine Operation Instructions	43
Control Panel	43
Operation Precautions	43
Freeze Protection	43
Cleaning and Chemical Precautions and Information	44
Cleaning Stroke Procedure/Over-Wetting	44-45
Maintenance Procedures	45
Overall Care of Machine	45

GENERAL INFORMATION

This manual contains installation and operation instructions as well as information required for proper maintenance, adjustment and repair of this unit. Since the first and most important part of repair work is the correct diagnosis of the trouble, a general troubleshooting section and component manual troubleshooting charts have been included for your convenience.

Unlike the garden tractor, lawnmower and cement mixer, all having one or two functions to perform, the truck-mounted carpet cleaning plant has many functions to perform simultaneously.

- Engine has to run consistent RPM.
- Vacuum has to pull air and dirty water back from cleaning site.
- Water pump provides stable pressure at proper water flow for cleaning.
- Chemical has to be injected into the water stream at the right consistency.
- Heater must maintain proper heat.
- Vacuum tank must store dirty water until drained.

As you can see, it is not just a turn key operation with only one thing to worry about, **Does it start?!**

THE SYSTEMS WORK AS FOLLOWS:

The water system takes incoming water at tap (low) pressure, combines it with chemical from the chemical system automatically, pumps it under high pressure through the heating system and out to the cleaning tool. After being sprayed into the carpet being cleaned, the water/chemical/soil solution is extracted by the vacuum system and returned to the waste recovery tank.

As there is no guess work in the manufacture of these highly advanced cleaning plants, there must be none in preparing it to get the job done in the field. It is the purpose of this manual to help you properly understand, maintain and service your cleaning plant. Follow the directions carefully and you will be rewarded with years of profitable trouble-free operation.

It is imperative that **no section** be overlooked when preparing for operation of this equipment.

WARNING

The manufacturer uses this symbol throughout the manual to warn of possible injury or death.

CAUTION

This symbol is used to warn of possible equipment damage.

HYDRA-MASTER WARRANTY POLICY

Effective October 1, 1981

HYDRA-MASTER warranty covers only defective materials and/or workmanship for the periods listed. Labor, and/or diagnostic reimbursement is specifically excluded.

LIMITED WARRANTY

HYDRA-MASTER warrants products of its manufacture to be free from defects in material and workmanship if properly installed, maintained, and operated under normal conditions with competent supervision. No person, agent, representative or dealer is authorized to give any warranties on behalf of HYDRA-MASTER nor to assume for HYDRA-MASTER any other liability in connection with any of HYDRA-MASTER'S products. This warranty shall extend for the periods listed by component below from date of installation. If repairs or replacements are made by the Purchaser without HYDRA-MASTER'S written consent, HYDRA-MASTER'S warranty shall cease to be in effect. No allowance will be granted for any repairs or alterations made by the Purchaser without HYDRA-MASTER'S prior written consent.

Machinery, equipment and accessories furnished by HYDRA-MASTER, but manufactured by others, are warranted only to the extent of the original manufacturer's warranty to HYDRA-MASTER.

HYDRA-MASTER agrees at its option to repair at the point of shipment or to replace without charge f.o.b. point of shipment, any parts or parts of products of HYDRA-MASTER'S manufacture, which within the specified warranty period shall be proved to HYDRA-MASTER'S satisfaction to have been defective when shipped, provided the Purchaser promptly notifies HYDRA-MASTER, in writing, of such alleged defect.

HYDRA-MASTER'S liability to Purchaser, whether in contract or in tort arising out of warranties, representation, instructions, or defects from any cause shall be limited to repairing or replacing of the defective part or parts as aforesaid, f.o.b. point of shipment.

No liability whatsoever shall attach to HYDRA-MASTER until said products have been paid for.

Except as stated in this section and in the preceding section titled "Warranty" and except as to title, there are no guarantees or warranties of merchantability, fitness, performance or otherwise, express, implied or statutory, and HYDRA-MASTER shall have no liability for consequential, incidental or other damages, howsoever caused.

ENGINE: (Thru original Manufacturer. See Onan warranty)	1 year
VACUUM BLOWER: (Thru original Manufacturer. See Fuller warranty)	1 year
PROPANE HEATER:	1 year
VACUUM RECOVERY TANK/CHEMICAL MIX TANKS:	1 year
FRAME/COVER ASSEMBLIES:	1 year
HIGH PRESSURE PUMP: (Thru original Manufacturer. See Cat Pump warranty)	1 year
HIGH PRESSURE BY PASS VALVE:	90 days
CHEMICAL PROPORTIONING SYSTEM:	90 days
GAUGES, METERS, SWITCHES, WIRE HARNESS.	
FUEL PUMP:	90 days
INTERNAL MACHINE HOSE:	90 days
EXTERNAL VACUUM HOSE, SOLUTION HOSE.	
QUICK CONNECTORS:	30 days
SS CLEANING WAND: (Except valve & jet assembly)	1 year
BELTS, FITTINGS, O RINGS, FILTER SCREENS:	30 days
FILTER BAGS:	Not Covered by Warranty

Freezing of any one water or chemical related component will VOID all other implied warranty on all water or chemical related components, internal or external, of this equipment.

WARRANTY INFORMATION

To avoid misunderstandings which might occur between machine owners and manufacturer, we are listing causes of component failure that specifically voids warranty coverage. Such causes as listed below shall constitute **abuse or neglect**.

ENGINE: Operation at speed in excess of 2600 RPM. Failure to maintain proper oil level (oil should be checked every 5 running hours). Failure to use the proper oil viscosity and type (see engine manual). Use of other than manufacturer's recommended spark plug in engines. Failure to perform recommended maintenance as described on pages 3 and 4 of engine manual.

BLOWER: Failure to lubricate impellers daily with LPS-1 or WD-40 lubricant. Failure to lubricate bearings as recommended in blower manual. Failure to maintain proper oil levels in the blower. Failure to use the correct oil grade and viscosity as recommended in blower manual. Failure to properly maintain blower safeguard systems such as waste tank filter screen, vacuum safety relief valve in vacuum tank lid and waste tank automatic shut-off system.

HIGH PRESSURE WATER PUMP: Operation of pump at pressures over 1200 PSI. Failure to maintain proper oil level as recommended in pump manual. Failure to change oil in pump at recommended intervals. Failure to protect pump against freezing. Failure to maintain pump protection shut-off system. Failure to use water softener in hard water areas. Use of improper chemicals.

HEATER: Operation of heater without adequate water supply. Changing factory set propane regulator. Operating heater without proper ventilating. Failure to protect heater against freezing. Operating machine at water pressures over 1000 PSI. Overfilling of propane tank. Use of improper chemicals. Failure to use water softener in hard water areas.

VAC TANK: Failure to properly maintain filtering devices in tank. Failure to clean tank as recommended by manufacturer. Failure to maintain vacuum safety release in tank lid. Use of improper chemicals.

CHEM. PROPORTIONER: Use of improper chemical. Failure to use water softener in hard water area. Operating machine without proper chemical filter screen. Failure to protect against freezing.

CONTROL PANEL: Failure to protect flow meter and water pressure gauge against freezing.

VACUUM AND SOLUTION HOSES: Failure to protect hoses against freezing. Failure to protect hoses against burns from engine/blower exhaust. Damage to hoses from being run over by vehicles. Kinking or cracking from failure to store or unroll hoses correctly. Normal wear and tear from everyday use.

CLEANING WAND: Failure to protect against freezing. Obvious physical abuse of wand.

WARRANTY PROCEDURE

Warranty coverage is available to you **ONLY** through Hydra-Master Corporation, 20309 64th Ave. West, Lynnwood, Washington 98036; When warranty parts are needed, write **Hydra-Master Warranty Dept.** at the above address, or call the Warranty/Service Dept. at (206) 775-7275. **No collect calls will be accepted. Hours of the Warranty/Service Dept. are 8:00 - 11:30 am and 12:30 - 5:00 pm, Pacific Time.**

IMPORTANT

Hydra-Master's warranty policy provides replacement parts without charge for thirty (30) days to customers maintaining current account status. An invoice dated thirty (30) days from date of replacement

parts shipment will be sent to the customer for the amount of the parts sent. The customer's faulty parts **must be returned** for evaluation prior to the expiration of the thirty (30) day period. Upon warranty approval, a credit will be issued the customer for the replacement parts invoice. **Warranty disapproval or failure to return the faulty parts within the thirty (30) day period allowed will result in the customer being charged for the replacement parts sent.**

HOW TO ORDER

To obtain a proper diagnosis of your malfunction, and to order warranty replacement parts, it is important you follow the below procedure:

1. Call Hydra-Master Warranty/Service Dept. at (206) 775-7275
2. Give the Warranty/Service Representative the following information:
 - A. Name of your company and your address.
 - B. Equipment Model (i.e. Hydra-Cat, Bobcat 2, etc.)
 - C. Date of purchase.
 - D. Hours on the unit.
 - E. Serial number of unit.
 - F. Name of person authorized to order parts.
 - G. Salesman unit purchased from.
 - H. Description of malfunction.
 - I. Pressure readings on high pressure gauge with wand turned on and off.
3. If warranty replacement parts are needed, please specify method of shipment desired. **NOTE:** All replacement parts are sent **freight collect, via:**
 - A. U.P.S.
 - B. Air freight
 - C. Air mail
 - D. Air express
 - E. Auto Freight
4. Do not give malfunctioning parts to a Hydra-Master Sales or Service Representative. **All parts must be returned directly to Hydra-Master, freight prepaid.**

ONE FINAL NOTE:

Any questions you have regarding the warranty program should be directed to the Warranty/Service Dept. Personnel at Hydra-Master Corporation.

We shall always endeavor to be fair in our evaluation of your warranty claim, and shall provide you with a complete analysis of our findings.

PURCHASER'S RESPONSIBILITY

PRIOR TO ARRIVAL OF UNIT:

- Install $\frac{5}{8}$ " exterior plywood flooring in vehicle and cover with artificial turf.
- Have belly mounted propane tank installed on vehicle. Tank must be propane vapor type.

CAUTION

- Purchase heavy duty 42-60 amp hour battery and have battery 'slow' charged if new. If battery is not fully charged damage can occur to the engine charging regulator.

ACCEPTANCE OF SHIPMENT:

- If unit shows any outward signs of damage, do not sign the delivery receipt until you have closely inspected the unit and noted any damage on the delivery receipt. Have the freight company representative acknowledge the damage by signing the notation of damage on the delivery receipt.

READING OF OPERATION MANUAL:

- It is the purchaser's responsibility to read the unit operation manual and to familiarize himself with the information contained therein.

SALES REPRESENTATIVE RESPONSIBILITY

- The salesman from whom you purchased your unit is responsible for supervising the correct installation of the unit in your vehicle and thoroughly training you in its operation and maintenance.

CORRECT INSTALLATION INCLUDES:

Supervising the purchaser in the following:

- Installation of through-floor fittings for propane and gasoline fuel lines; installing propane regulator included with unit, outside vehicle; placing unit and recovery tank in vehicle and securing them with bolts or tie down cleats; connecting all propane and gasoline lines; connecting battery; checking pump, vacuum blower and engine oil levels, prior to starting unit; starting unit to check engine to see that all systems function normally; also checking all hoses, wands, etc., for correct operation.

TRAINING SHALL INCLUDE:

- Thorough review of the operation manual with purchaser; instruction and familiarization in: how to correctly start up and shut down unit; how to correctly clean with the unit; how, where and how often to check and change component oil levels; how the unit's systems work; how to troubleshoot the unit; how to do basic repairs; safety precautions and their importance; freezing damage and how to avoid it and a thorough review of the unit warranty and warranty procedures.

TRUCK PREPARATION

Manufacturer recommends the installation of plywood flooring covered with polypropylene backed astroturf (do not use rubber-backed) in the vehicle prior to installation of machine. This provides a metal to cushion mounting rather than metal to metal, provides insulation and makes an attractive van interior. Astroturf should be color

Materials Needed:

1. 2 sheets 4 x 8 x $\frac{5}{8}$ " exterior plywood
2. 6' x 12' piece of commercial astroturf
3. 16 - 1 $\frac{1}{2}$ " sheet metal screws
4. 1 quart marine adhesive (optional)
5. 1 staple hammer w/ $\frac{1}{2}$ " staples

(See illustration for correct placement of plywood flooring)

PLACEMENT OF UNIT IN VEHICLE

There are two recommended unit placements:

A. **SIDE DOOR:** Most installations are side door. This provides rear access for accessories and hoses as well as unobstructed access to component/working side of machine, thus making it a bit easier to perform maintenance and/or repair without removing unit from the truck.

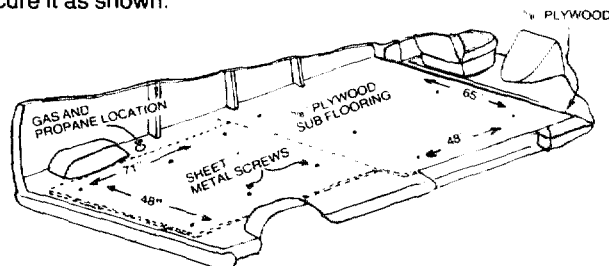
B. **REAR DOOR:** Although this location partly limits working access, it does direct the noise away from the cleaning site. Some cleaners in the colder areas prefer this location because it puts the weight mass over the rear wheels for better traction in ice and snow. Rear mounting requires the unit to be slid to the right side as far as possible. This not only provides adequate working space on the component side of the unit but also makes better weight distribution inside the van (engine and component weight line up over drive shaft). Also, it is physically easier to load unit into rear door due to height of van bed.

WARNING

Ensure that machine is well secured to the floor of van with hardware supplied. Sudden or crash stop will cause machine to rocket forward, all 350 lbs. worth! Protect yourself and the machine: **SECURE IT!**

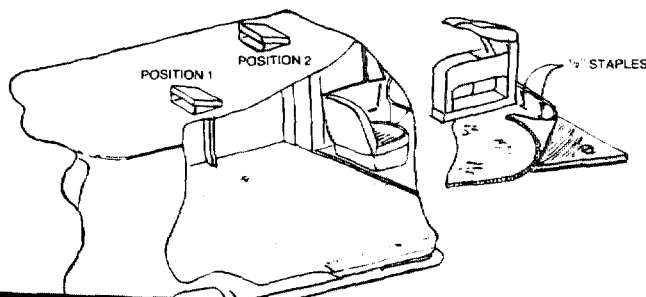
TRUCK PREPARATION ILLUSTRATION

FIRST, cover the truck bed with $\frac{5}{8}$ " plywood using metal screws to secure it as shown.



SECOND, select the appropriate color astro turf to match your van and cover the plywood and staple in place. A standard van requires a piece 6 feet by 12 feet.

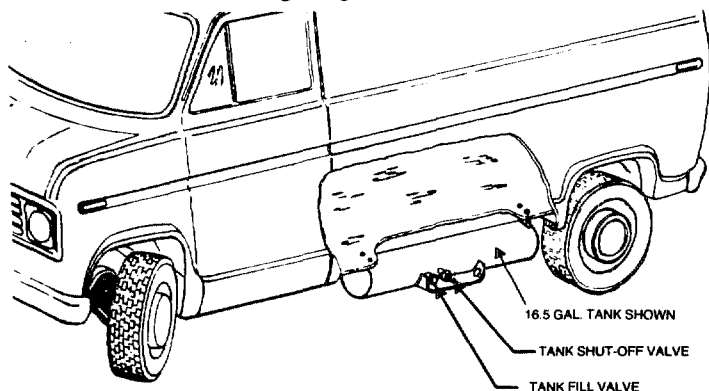
THIRD, for added ventilation, an aluminum roof vent should be added over the location selected for mounting the machine. This will allow hot air from the heater to escape.



PROPANE TANK LOCATION

Either the 10 gallon or 16.5 gallon propane tank will fit this location. Have your local propane dealer install the tank you select and purchase. The machine will come with the proper propane regulator. (Tank must have vapor outlet).

WARNING Do not use a portable propane tank inside the truck or van. Besides being dangerous it is unlawful in most states.

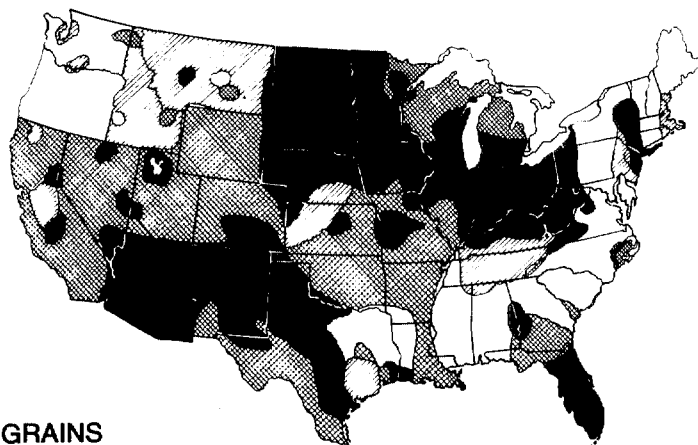


HARD WATER AREA MAP

The quality of water varies greatly throughout the United States and influences the reliability and efficiency of equipment in direct proportion to its level of hardness. The map below defines areas which compromise fluid related components such as hoses, fittings, heaters, pumps, valves and water cooled engines.

Cleaning efficiency and equipment life is increased, chemical use decreased and the appearance of cleaned carpets enhanced when water softeners are incorporated in hard water areas. Manufacturer strongly urges the use of water softener units in areas exceeding 3½ grains per gallon. Using the legend as a reference, determine the quality of water in your area and take action immediately should it be necessary.

(For installation diagram see machine installation section)



GRAINS PER GALLON



MACHINE SPECIFICATIONS

5

SPECIFICATIONS:

- FRAME:** 18" W, 46" L, 33" H. Steel With Baked-On Epoxy Finish.
- WEIGHT:** 475 Pounds.
- COWLING:** Steel With Baked-On Epoxy Finish
- ENGINE:** **L/Series** 20 BHP Onan B48G. Opposed two: cylinder, four cycle.
S/Series CCKB 20BHP Onan Opposed, Two Cylinder, Four Cycle.
- IGNITION:** Standard Points, Keystart.
- HI-PRESSURE PUMP:** Tri-Plex Piston - Cat 290 - 3.5 GPM - 1200 PSI - @ 1200 RPM.
- VACUUM BLOWER:** 4MF Sutorbuilt W/14 HG Safety Relief.
- CHEM. SYSTEM:** Auto Proportioning Flow Meter Controlled.
- HEATER:** Propane Fired, Thermostatically Controlled. (120,000 BTU).
- INSTRUMENTS:** 1-1000 High Pressure Gauge, Temp. Gauge, Vacuum Gauge, Hour Meter, Chemical Flow Meter, Ignition Key Start and on Ind. Lights.
- RECOVERY TANK:** 65 Gallon Aluminum Epoxy Finish.
- CLEANING WAND:** Stainless Steel W/Heat Shield Grip and Replaceable Vacuum Lips.
- HI-PRESSURE HOSE:** ¼" High Temp Lined/Vinyl Covered Safety Orange W/Brass Quick Connects. Rated Up to 3000 PSI, 250° Max.
- VACUUM HOSE:** 2" Reinforced Safety Orange, 1½" Reinforced Safety Orange.
- STANDARD FEATURES:** Basic Console, 65 Gallon Vacuum Tank, 11" S/S Cleaning Wand, 100' ¼" High Pressure Hose, 90' - 2" Vacuum Hose, 10' - 1¼" Vacuum Hose, Battery Box, Through Floor Connections For Gasoline and Propane Hook-up, Tie-Down Cleats, Vacuum Hose Connections, Operation Manual.
- OPTIONAL FEATURES:** Stair Tool, Steel Legs W/Casters, Additional 2" Vacuum Hose in 50' Lengths, Additional ¼" Pressure Hose In 50' Lengths, Pressure Washing Gun, Spare Parts Package, Clutch, Built-in Freeze Guard.

SPARE PARTS RECOMMENDATION

Because your truck-mounted unit is capable of generating several hundred dollars per day, down-time on the unit can be very expensive.

In order to minimize such down-time, it is strongly recommended by the manufacturer that you purchase and keep in your truck the following spare parts:

QUANTITY	PART NUMBER	DESCRIPTION
2		Engine Spark Plug
1	000-078-015	Flow Meter Kit
1	000-078-024	Wand Valve Plunger Kit
1	000-078-034	Press. Bypass Valve Kit
1	000-076-007	Spray Jet 8008E
2	000-049-028	Recovery Tank Filter Bag
1	000-078-001	Cat 290 Short Cup Kit Standard
1	000-078-004	Cat 290 Hot Cup Kit (Optional)
6	000-049-023	Screen Garden Hose
1	000-052-050	440 Male Quick Connect
1	000-052-051	440 Female Quick Connect
1	000-052-052	660 Male Quick Connect
1	000-052-053	660 Female Quick Connect
1	5L380 H/L 5L390 H/S	Belt, Pump Drive.

PARTS ORDERS

To expedite your parts needs, please call your sales representative. In most instances, he either stocks or has access to parts through a regional service center.

In the event parts are unavailable locally, contact the factory and coordinate your needs. If this becomes necessary, always indicate the method of shipment you desire, i.e. U.P.S., U.P.S. Blue Label, Air Freight, Air Express, etc..

Hydra-Master Parts Dept. phone (206) 775-7276.

WATER AND CHEMICAL FLOW OPERATION

This system has been designed to be the most simple and trouble-free ever.

The incoming water flows directly to the mix tank. Water will now flow through a proportioning valve which will simultaneously mix the chemical to achieve your desired solution. The mix tank is equipped with 2 different float valves, one of which responds to the water level of the tank and will maintain the proper volume of solution to be reserved for the cat pump. The secondary float valve is a safety valve that is designed to protect your system from sudden or unexpected loss of water supply. If, for example, the water source at the house the secondary valve which automatically kills the engine.

UNIT WITH CLUTCH: if mix tank water level drops, clutch will disengage.

In conjunction with the incoming flow, the chemical ratio may be obtained by an adjustment of the chemical flow meter during the fill

cycle of the mix tank. The chemical will flow from the chemical jug to the chemical flow meter, then to the proportioner where it is distributed into the mix tank at your desired proportion. This line should be flushed with vinegar weekly to prevent abnormal chemical build-up. This may be done by removing the clear plastic hose from the chemical jug and inserting it into a one quart container of vinegar. This should be done with the chemical flow meter setting on 10 GPH with heater "off". Simply spray the wand for the duration of the vinegar in the one quart container, then repeat the process with one quart of clear water to void all lines of vinegar.

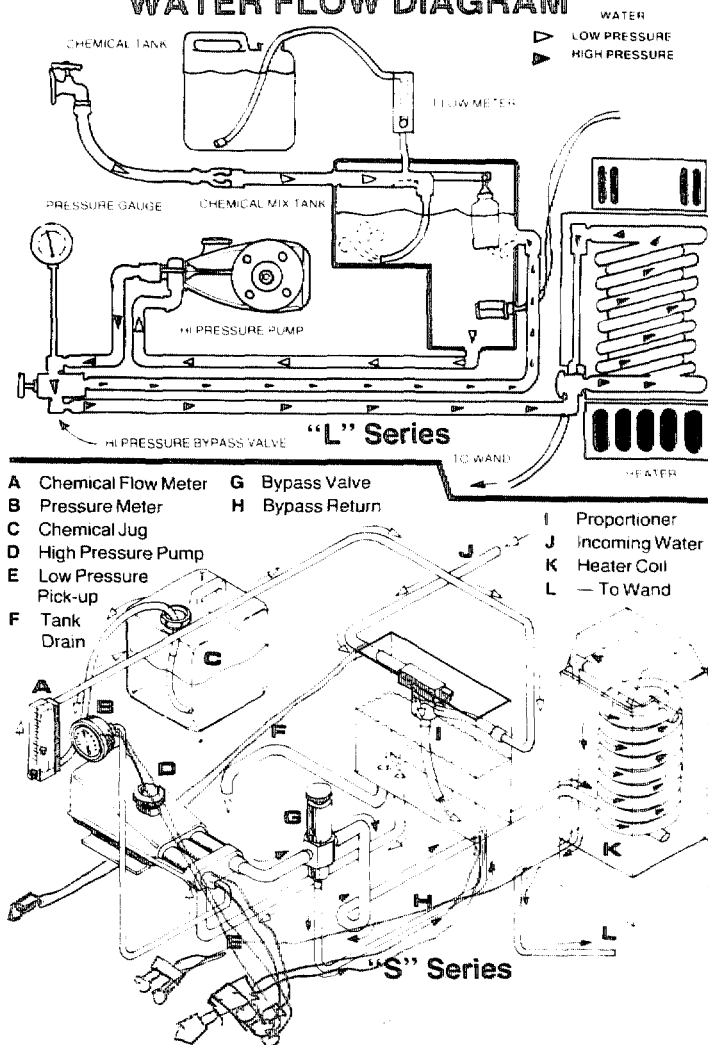
NOTE: with this unique chemical system, your chemical flow is proportioned to the filling cycles of the mix tank, not the direct spraying of the wand. Therefore, it is possible that as your wand is spraying, you may have no chemical flow. Also, the converse is true in that you may not be spraying your wand but, if the mix tank is in a filling cycle, your chemical flow meter may read your desired flow.

This chemical system will mix a 1 to 30 ratio when flow meter is set at 5 GPH. Most chemical suppliers will recommend a 1 to 15 ratio, therefore you can either set the flow meter at 10 GPH, giving you a 1 to 15 ratio of chemical to cleaning water, or double the recommended strength of chemical in the 5 gallon jug and set the flow meter at 5 GPH, thereby attaining a 1 to 15 ratio. (It is recommended that you set the flow meter at 10 GPH for overall best results.)

The water will now be siphoned from the bottom of the mix tank to the Cat Pump. If the wand is not spraying, the water will bypass from the bottom of the brass pressure relief valve to the mix tank.

If the wand is spraying, the water will then flow to the heater. This heater has a capacity of up to 2 gallons, therefore it is extremely important that all air is bled out of the heater prior to initial start-up. This may be achieved by running the system, without the heater on, for approximately 60 seconds.

WATER FLOW DIAGRAM



GENERAL INFORMATION FOR CAT PUMP REPAIR

As you remove your discharge manifold, there is a set of 3 check valves (which usually fall out during dis-assembly). If the surfaces of these check valves are dirty, or show signs of chemical build-up, it is probable that they would remain open causing pressure loss or pulsation. Upon inspecting the valves, make sure that the teflon buttons in the valve spring retainers are still intact. Also examine the discharge manifold. Look for problems such as cracks, chemical build-up or warpage due to freezing. If this discharge manifold is warped, it will cause the check valves to stick and will result in loss of pressure.

The Cat pump cups are often the source of pressure loss. Upon inspection they may appear melted or torn, but often they will look good. Replace them anyway. There is no sure method of visually inspecting the cups. Hydra-Master recommends changing cups whether they look good or not.

Anytime your pump is being dismantled, Hydra-Master recommends replacement of all 'o' rings and seals. This is merely a convenience to the customer to make sure that the Cat pump is in top operating condition.

The prrrm-a-lube seals located within the intake manifold will allow air to enter the pump if they are worn. Again, it is difficult to visually pinpoint a defective prrrm-a-lube seal. Replace them all.

Within the piston sleeve cylinders there are 6 'o' rings that are about 1/4 the size of a penny. If these 'o' rings are bad, water will be pumped back into the oil. If this has occurred the oil will raise in level and will appear milky. If you are unable to repair seals right away, change oil frequently. Repair the pump as soon as possible so as to not damage bearing or connecting rods.

Repairing of Cat pumps is not a difficult task. However, before disassembling make sure you have the proper parts required.

- 1 - short (or hot) cup kit
- 6 - piston sleeve 'o' rings
- 3 - Prrrm-a-lube seals
- 1 - bottle Cat oil

Read instructions thoroughly, supplied in the Cat pump manual, prior to disassembly and follow directions as stated. Oil all seals thoroughly prior to installation. (Remember, a newly scarred seal is no better than one you just took out.)

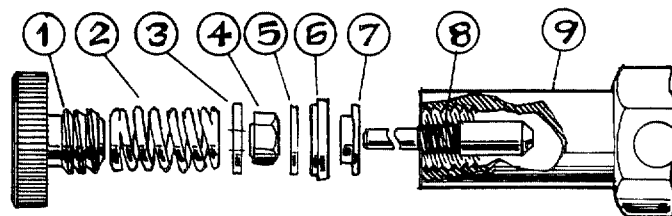
BYPASS VALVE ILLUSTRATION

TO SERVICE BYPASS VALVE

- Unscrew knurled knob and remove.
- Wiggle protruding shaft with fingers or pliers, pull up and remove from main body.

SPECIAL INSTRUCTIONS - BYPASS VALVE

- #4 - 5/16" fine thread
- #6 - Cup seal (if leather, replace or lube with leather oil).
- #7 - Brass bushing
- #8 - Shaft - if cup needs replacement, place thin end of shaft only in vise and remove 5/16" nut. Flat end is "seating" surface and must be free of abrasion to properly seat. **NOTE: IMPORTANT** -when replacing seals, only wrench nut #4 to where cup will not turn on shaft. If cup is too loose, bypass will leak. Too tight, cup will flange and bypass will leak.



HIGH PRESSURE PUMP TROUBLESHOOTING

A pump instruction brochure on pages 8 - 15 may assist you in resolving a pump related problem.

PROBLEM:

● LOSS OF PRESSURE

CAUSE AND/OR SOLUTION:

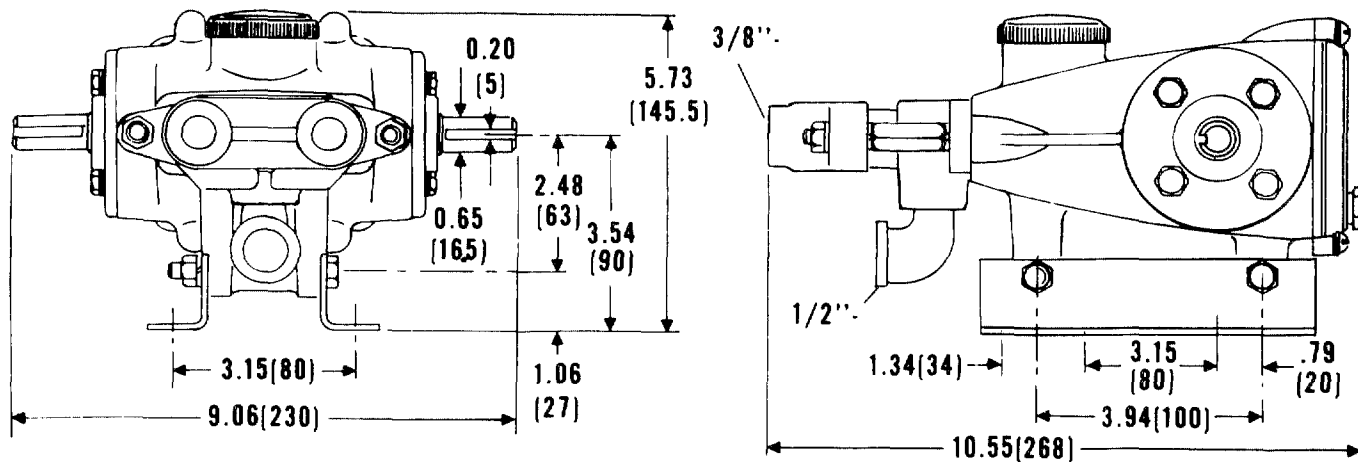
1. **Defective or blocked check valves in high pressure pump cylinder head.**
 - A. Disassemble cylinder head and replace or clean applicable check valve.
2. **Delaminated, kinked or clogged hose between the mix tank and the high pressure pump.**
 - A. Remove and replace defective hose.
3. **Defective pressure relief valve or debris in pressure relief valve.** NOTE: the high pressure bypass valve is designed to fully close when the cleaning tool is turned on. Any foreign matter collecting on the piston will prevent full closure of the valve and allow a portion of the water to continue to circulate instead of being routed to the cleaning tool. To correct this situation, the bypass valve must be disassembled and cleaned (refer to drawing provided in this manual for bypass disassembly).
 - A. Disassemble and clean pressure relief valve as illustrated in drawing.
 - B. Replace defective or worn out bypass cup.
 - C. Replace bypass valve.
4. **Defective or worn cups.**
 - A. Remove and replace piston cups as defined by pump manual.
5. **Loose drive belt for high pressure pump.**
 - A. Readjust belt as required or replace if defective.
6. **LOSS OF PRESSURE/Unit With Clutch**
 - Is clutch engaged? Check tank for water.

WATER FLOW

1. **Worn out spray jet.** NOTE: Cleaning tools designed to spray a constant flow of 1 1/2 GPM will average 1 gallon of flow per minute in actual working situations since flow is not continuous. An average flow of 1 GPM results in 6000 gallons of flow for every 100 hours of unit operation. Spray tips are capable of consistent flow rates for approximately 20,000 gallons. They should be replaced therefore, approximately every 350 hours. Worn spray jets allow a greater average rate of flow thus reducing desired temperature levels.
 - A. Remove and replace spray jet.

(Continued on Page 16).





IMPORTANT DRIVE INFORMATION

HORSEPOWER REQUIREMENTS				Pulley Selection Using 5" Pump Pulley		
Flow		PRESSURE			RPM	Motor Pulley O.D.
		800 PSI	1000 PSI	1200 PSI		
GPM	L/M	55 BAR	69 BAR	83 BAR		
3.5	13	1.9	2.4	2.9	1200	3.5
3.0	11	1.7	2.1	2.5	1029	3.0
2.5	9	1.4	1.7	2.1	858	2.5

Pump speed and pump output in gallons per minute as tabulated is based upon a 1725 RPM drive motor. Select motor pulley size to provide GPM of the approximate pump output desired.

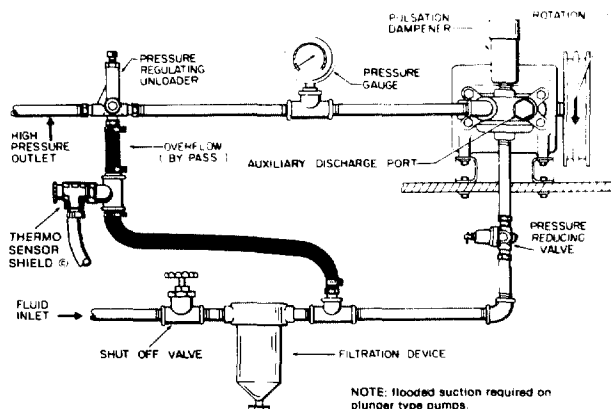
Pump RPM and GPM output are approximate values due to variations in pulleys, belts and motors between manufacturers and a + - 5% pump output tolerance.

Horsepower figures shown are brake horsepower figures. For gas engine requirements, follow engine manufacturer's recommendations. In general, use a gas engine with approximately double the electric motor horsepower.

TYPICAL INSTALLATION

The illustration at the right shows the basic elements for the proper installation of a high-pressure pump. Each component offers potential problems that too often are ascribed to a perfectly functioning pump. A clogged strainer, a partially closed shut-off valve or a faulty pressure gauge or pressure regulating unloader may be the source of trouble.

Proper system installation, routine lubrication and monitoring of components are your best and guarantees of optimum pump performance. These precautions will eliminate most problems, minimize corrective maintenance, and give many, many added hours of trouble free operation. Cat Pumps Corporation does not assume any liability or responsibility for the operation of a customer's high pressure system.



GENERAL INFORMATION

INTERPRETING PRESSURE READINGS: Pressure readings that differ from the rated PSI or those normal for a particular set-up indicate a problem, *but not necessarily a pump problem!*

Before any servicing of the pump, carefully check the following; inlet plumbing for size, restriction and/or air leaks, restricted or worn orifice and condition of the by-pass valve and pressure gauge. Check any shut-off valves in the inlet or discharge plumbing to be sure they are fully open. Seven out of ten problems are other than pump problems!

FOR SERVICE contact your local representative or look in the Yellow Pages under **PUMPS**.

ORDERING OF PARTS: When ordering parts, be sure to give the "model number" and "serial number", "description", and "quantity" of the items desired.

MATERIAL RETURNS: If necessary to return a Cat Pump, please secure an approved "RETURN GOODS AUTHORIZATION" form from Cat Pumps Corporation and complete a "PRODUCT REPORT" form detailing the application and the conditions of operation. Any material AUTHORIZED for return must be shipped **FREIGHT PREPAID**.

FILTER INSPECTION: A frequent source of low pressure is due to foreign matter in the fluid being pumped. It takes but one small particle to partially hold open a valve—several to plug an inlet screen or filter, or if the particles are abrasive, to damage packings, valves, valve seats, or plungers.

Inspect filters and screens on a schedule commensurate with the material being pumped and whenever a low pressure problem develops.

NOZZLES: A worn nozzle will result in loss of pressure.

INSTALLATION

Optimum performance of the pump is dependent upon the entire fluid system and will be obtained only with the proper selection and installation of plumbing and accessories.

Lubrication: Fill crankcase with oil as covered under warranty conditions.

Pulley Selection: Select size of motor pulley required to deliver the desired volume from Horse Power Requirement and Pulley Selection Chart.

Motor Selection: The motor or engine driving the pump must be of adequate horsepower to maintain full RPM when the pump is under load. Select a motor from the Horse Power Requirement Chart according to required pump discharge volume and maximum pressure *at the pump!*

Mount the pump on a rigid, horizontal surface in a manner to permit drainage of crankcase oil. An uneven mounting surface will cause extensive damage to the pump base. Use the correct belt; make sure pulleys are aligned. Excessive belt tension may be harmful to the bearings.

Inlet Plumbing must be at least the same diameter as the inlet port, preferably one size larger. Restriction in the inlet plumbing will cause cavitation in the pump, drastically reducing packing life. All joints must be air tight.

Inlet Pressure: Optimum performance is obtained with + 20 PSI inlet pressure. With adequate size inlet plumbing, the pump will perform very satisfactorily with

flooded suction. The pump can operate with inlet pressure up to 40 PSI. Use of excessive pressure will void the warranty.

Inlet Accessories: Install an inlet strainer of twice the rated capacity of the pump.

A stand pipe to help maintain a positive pressure head in the inlet line is desirable.

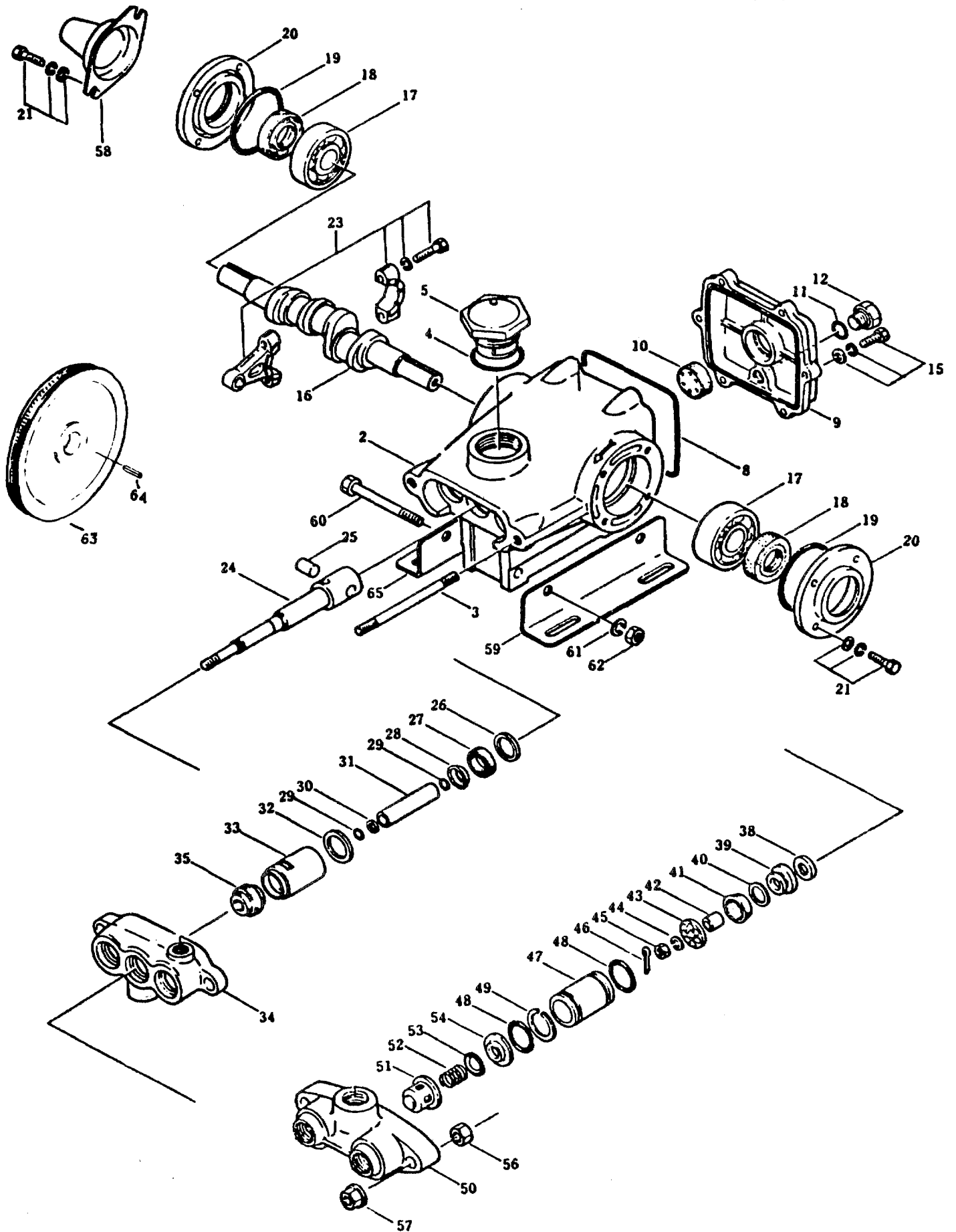
A shut-off valve is recommended to facilitate maintenance.

Discharge Plumbing: *Install a pulsation dampening device mounted directly to the discharge line and precharged to a pressure calibrated for operating conditions.*

A reliable pressure gauge should be installed near the discharge outlet of the high pressure manifold. This is extremely important for adjusting pressure regulating devices and also for proper sizing of the nozzle or restricting orifice. The pump is rated for a maximum pressure; this is the pressure which would be read at the discharge manifold of the pump, not at the gun or nozzle end of a long hose.

A pressure regulating relief valve or unloader must be installed to prevent over-pressure in the event the discharge or downstream plumbing becomes plugged or is turned off. Severe damage to the pump will result if this condition occurs without a relief valve in the line. CAUTION: Failure to install such a valve will void the warranty on the pump.

EXPLODED VIEW MODEL 290



PARTS LIST

CAT PUMP MODEL 290

ITEM

ITEM	PART NO	DESCRIPTION	QTY.	ITEM	PART NO.	DESCRIPTION	QTY.
2	28766	Crankcase	1	38	27004	Inlet Valve	3
3	85680	Stud (M8 x 82)	2	39	30543	Bac-Cup Piston	3
4	14177	O-Ring, Oil Filler Cap	1	40	30544	Bac-Cup Ring (Teflon)	3
5	43211	Oil Filler Cap	1	41	43172	Cup (Viton)	3
8	26087	O-Ring,Crankcase Cover	1	42	27983	Piston Spacer	3
9	26105	Crankcase Cover	1	43	27002	Piston Retainer	3
10	22289	Oil Gauge	1	44	27006	Conical Washer-SS (M6)	3
11	23170	O-Ring, Drain Plug	1	45	18956	Nut-SS (M6)	3
12	25625	Drain Plug	1	46	14158	Cotterpin	3
15	92520	Sems Comb Head Screw (M6 x 20)	6	47	101802	Cylinder(43834 Unch)	3
16	43804	Crankshaft	1	48	23172	O-Ring, Cylinder	6
17	14487	Rearing	2		11377	O-Ring, Cylinder (Viton)	6
18	24159	Oil Seal	2	49	21985	Bac-Up Ring, Cylinder	3
19	26536	O-Ring, Oil Seal Case	2	50	24459	Discharge Manifold	1
20	27950	Oil Seal Case	2		25634	Discharge Manifold- Stainless Steel	1
21	92519	Sems Comb. Head Screw (M6 x 16)	8	51	43442	Valve Spring Retainer	3
23	101799	Connecting Rod	3	52	43360	Valve Spring	3
24	101800	Piston Rod	3	53	43723	Valve	3
25	16948	Piston Pin	3	54	43434	Discharge Valve Seat	3
26	20017	Seal Washer	3	56	81109	Hex Nut (M8)	2
27	25301	Oil Seal	3	57	101804	Hex Flange Nut (M8)	2
28	25327	Barrier Slinger	3	58	25130	Shaft Protector	1
29	25392	O-Ring, Sleeve	3	59	26246	Angle Rail	2
	28771	O-Ring, Sleeve (Viton)	3	60	30901	Hex Cap Screw (5/16 x 2 3/4)	2
30	29003	Back-Up Ring, Sleeve	3			30612 Angle Mounting	2
31	29614	Sleeve (29743 Unchromed)	3	61	30920	Split Lockwasher (5/16 US)	2
32	26854	Seal Washer	3			30246 Pulley Asbly.	1
33	28597	Seal Retainer	3	62	30910	Hex Nut (5/16 US)	2
34	25128	Inlet Manifold	1	63	30032	Pulley 5" w/2 Set screws	1
	25635	Inlet Manifold-Stainless Steel	1	64	30047	Key (M5)	1
35	30315	Prrrrrm-A-Lube Seal	3				
	30325	Prrrrrm-A-Lube Seal(Viton)	3				

SERVICE KITS

30023 Cup Kit

- 3 Cup
- 6 O-Ring, Cylinder
- 3 Cotterpin
- 1 Instruction Sheet
- 1 Cup Inserter

30305 Seal Kit

- 3 Prrrrrm-A-Lube Seal
- 3 Cotterpin
- 2 Abrasive Paper
- 1 Instruction Sheet

30431 Sleeve and Seal Kit

- 3 Prrrrrm-A-Lube Seal
- 3 Barrier Slinger
- 3 Cotterpin
- 3 Sleeve
- 6 O-Ring, Sleeve
- 1 Instruction Sheet

30686 Valve Kit

- 3 Valve Spring Retainer
- 3 Valve Spring
- 3 Valve
- 3 Valve Seat
- 3 O-Ring, Cylinder
- 1 Instruction Sheet

30860 Piston Kit

- 6 O-Ring, Cylinder
- 3 Back-Up Ring,Cylinder
- 3 Bac-Cup Piston
- 3 Bac-Cup Ring
- 3 Cup
- 3 Piston Spacer
- 3 Piston Retainer
- 3 Conical Washer (M6)
- 3 Nut (M6)
- 3 Cotterpin
- 3 Inlet Valves
- 1 Instruction Sheet

SERVICING DISCHARGE VALVES & VALVE SEATS

13

DISASSEMBLY

1. Loosen the 2 (M8) locking nuts approximately one turn.
2. Then remove the 2 (M8) flange nuts.
3. Grasp the discharge manifold with 3 fingers on the underside and tap with a soft mallet to remove
4. Valve assemblies will remain with the manifold. Invert manifold and discharge valve assemblies should fall out.
5. Inspect discharge valves for wear or ridges. (Spherical valves due to their shape must be replaced when worn.)

REASSEMBLY:

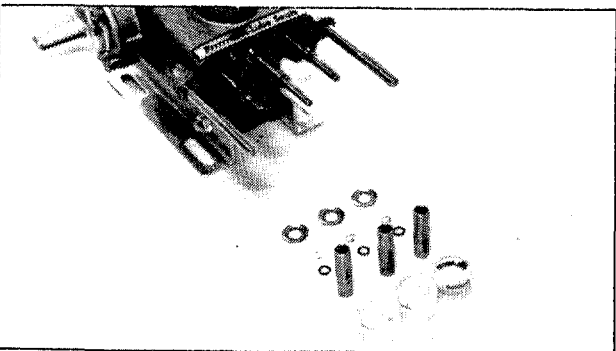
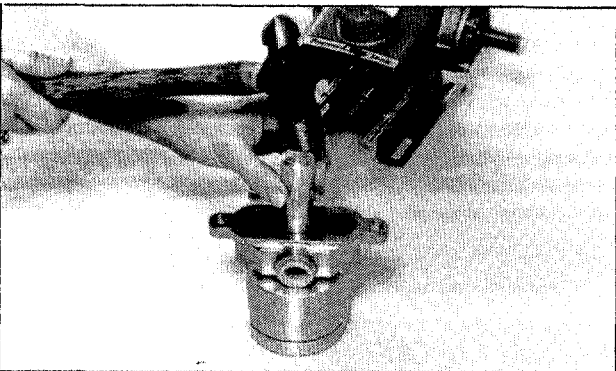
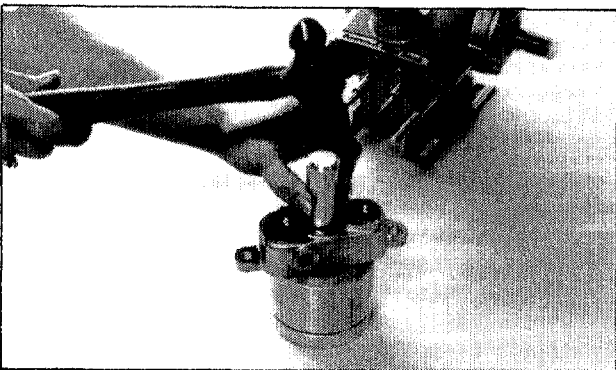
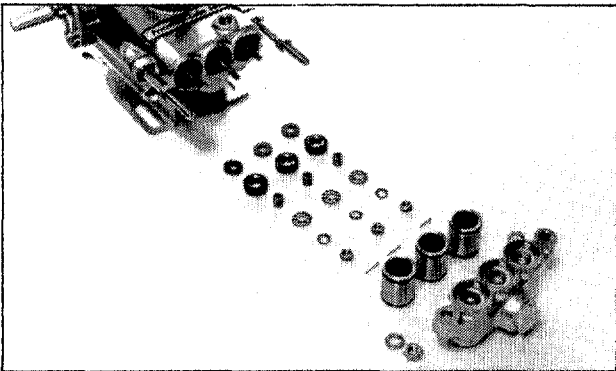
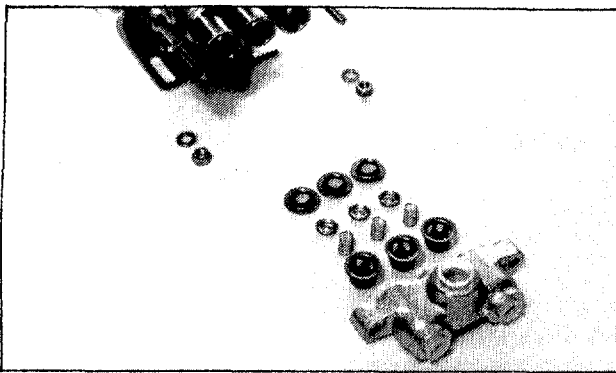
1. Place retainer in manifold chamber.
2. Next insert spring into center of retainer
3. Place valve over spring with spherical (mooned) side down.
4. Next insert the valve seat.
5. Position manifold back onto pump. NOTE: *Exercise caution when inserting cylinders into manifold to avoid damaging cylinder o-rings.*
6. Replace flange nuts on studs and hand tighten both sides. Then torque each side to 125 inch pounds.
7. Hand tighten locking nut.

CAUTION: *When restarting the pump, check to see that there is no cylinder motion as this will cause premature failure of the cylinder o-rings. Center cylinder motion can be eliminated by switching with one of the endcylinders.*

SERVICING THE PUMPING SECTION

DISASSEMBLY:

1. Remove discharge manifold as described above.
2. Slip cylinders out of inlet manifold.
NOTE: *Identify cylinders so they will be relaced in their origional position. (Front to back)*
3. Remove cotterpin, nut, and washer.
4. Next remove piston retainer, spacer, and piston assembly.
5. Remove inlet valve.



SERVICING THE SEALS AND SLEEVES

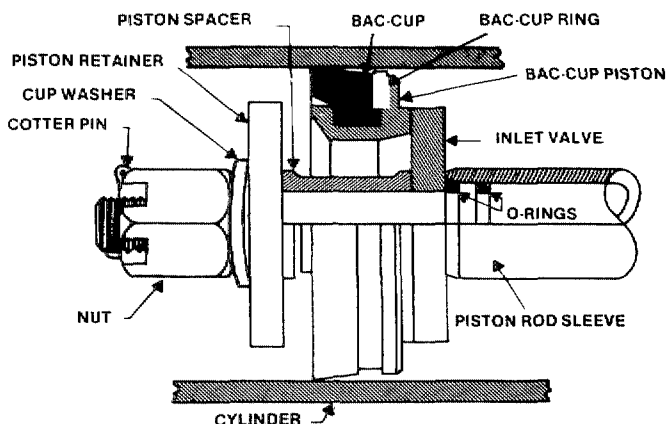
14 REASSEMBLY:

1. Examine inlet valve surface and reverse if damaged. (both sides are lap surfaces.)
2. Examine piston assembly for clean inlet surface. If damaged, replace and lubricate.

NOTE CUP INSTALLATION:

Wipe cup inserter lightly with oil. Slip bac-cup ring onto piston. Force cup over inserter and square with all surfaces. Faulty cup installation causes premature failure.

3. Next replace piston spacer and retainer.
4. Slip washer onto rod, screw on nut and torque to 60 inch pounds. NOTE: ALWAYS REPLACE WITH NEW COTTERPIN.
5. Examine cylinder walls for scoring or etching. These conditions will cause premature wear of your piston assemblies. replace if worn or damaged.
6. Lubricate cylinder and replace o-rings and back-up rings (if defective).
7. Position cylinders in their original order into manifold chambers and carefully slip over rod ends onto the pump.
8. Replace flange nuts on studs and hand tighten both sides. Then torque each side to 125 inch pounds.
9. Hand tighten locking nuts.



PUMPING SECTION CUTAWAY

DISASSEMBLY:

1. Remove discharge manifold and piston assemblies as described.
2. Remove both (M8) locking nuts from studs
3. With soft mallet, tap inlet manifold loose from crankcase.
4. Place inlet manifold on pair of clearance blocks with crankcase side down. and drive out seals.
5. Invert inlet manifold with CRANKCASE SIDE UP.
6. Lubricate circumference of new Prrrrm-A-Lube seals, position in manifold with GARTER SPRING DOWN and drive into place.
7. Examine sleeves for scoring or other damage before removing
8. If worn, grasp sleeve with pliers and pull off. NOTE: *This procedure will mar the sleeve so use only if sleeve is to be replaced.*
9. Remove o-ring and back-up rings from piston rod.

REASSEMBLY:

1. Place barrier slinger on rod.
2. Lubricate new o-rings and back-up rings. Install first o-ring in the o-ring groove on the piston rod. Position back-up ring against the shoulder in front of the first o-ring, then the second o-ring. Be careful to avoid damaging the o-rings when slipping them over the piston rod threaded ends.
3. Immerse sleeve in oil carefully twist and push onto rod. (machined counter bore end first).
4. Replace seal retainers.
5. Exercise caution when replacing inlet manifold, so the inlet seals are not damaged by the threaded rod ends.
6. Replace locking nuts on studs.
7. Reassemble piston assemblies and discharge manifold as described.

Consult factory for your local distributor for crankcase servicing.

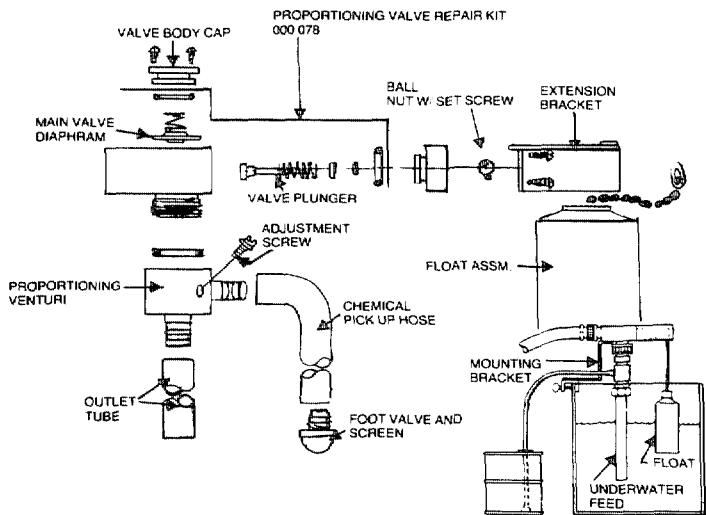
DIAGNOSIS AND MAINTENANCE

PROBLEM	PROBABLE CAUSE	SOLUTION	PROBLEM	PROBABLE CAUSE	SOLUTION
Pulsation	Faulty Pulsation Dampener	Check precharge; if low recharge it or install a new one	Excessive play in the end of the crankshaft pulley	Worn main ball bearing from excessive tension on drive belt	Replace ball bearing. Properly tension belt.
Low Pressure	Worn nozzle	Replace nozzle, of proper size	Water in crankcase	May be caused by humid air condensing into water inside the crankcase	Change oil at 3 month or 500 hour intervals using Cat Pump Crankcase Oil (other approved oil every month or 200 hours) P.N. 06100.
	Belt Slippage	Tighten or replace; use correct belt		Leakage of manifold inlet seals and/or piston rod sleeve O-ring	Replace seals, sleeve and O-rings.
	Air leak in inlet plumbing	Disassemble, reseal, and reassemble		Oil leaking from underside of crankcase	Worn crankcase piston rod seals
	Pressure gauge inoperative or not registering accurately	Check with new gauge; replace worn or damaged gauge, P.N. 06090	Oil leaking at the rear portion of the crankcase		Damaged or improperly installed oil gauge or crankcase rear cover O-ring, and drain plug O-ring
	Relief valve stuck, partially plugged or improperly adjusted; valve seat worn	Clean, and adjust relief valve; check for worn and dirty valve seats. Kit Available.	Oil leakage from drain plug	Loose drain plug or worn drain plug O-ring	Tighten drain plug or replace O-ring
	Inlet suction strainer clogged or improper size	Clean. Use adequate size. Check more frequently.	Loud knocking noise in pump	Pulley loose on crankshaft	Check key and tighten set screw.
	Worn piston assembly Abrasives in pumped fluid or severe cavitation. Inadequate water supply.	Install proper filter. Suction at inlet manifold must be limited to lifting less than 20 feet of water or -8.5 PSI vacuum.		Broken or worn bearing	Replace bearings
	Fouled or dirty inlet or discharge valves	Clean inlet and discharge valve assemblies. valves	Frequent or premature failure of the inlet manifold seals	Scored rods or sleeves	Replace rods and sleeves.
	Worn inlet or discharge valves	Replace worn valves, valve seats and/or discharge hose.		Over pressure to inlet manifold	Reduce inlet pressure per instructions
Leaky discharge hose		Short cup life	Damaged or worn chrome plating of the cylinders	Replace cylinders	
Pumps runs extremely rough, pressure very low	Restricted inlet or air entering the inlet plumbing		Proper size inlet plumbing; check for air tight seal	Abrasive material in the fluid being pumped	Install proper filtration on pump inlet plumbing
	Inlet restrictions and/or air leaks. Damaged cup or stuck inlet or discharge valve		Replace worn cup or cups, clean out foreign material, replace worn valves	Excessive pressure and/or temperature of fluid being pumped	Check pressures and fluid inlet temperature; be sure they are within specified range
	Worn inlet manifold seals		Replace worn seals.	Over pressure of pumps	Reduce pressure
	Worn inlet seals allow pump to draw air.		Install new inlet manifold seals.	Running Pump dry	Do not run pump without water
Cylinder O-rings blown next to discharge manifold	Pressures in excess of rated PSI		Check for plugged nozzle, closed valves or improperly adjusted by-pass valve	Front edge of piston sharp	Replace with new piston
	Warped manifold	Replace manifold	Chrome plating of cylinders damaged causing excessive wear of cups. May be caused by pumping acid solution.	Install new cups and cylinders. Pump only fluid compatible with chrome	
Leakage at the cylinder O-rings at the discharge manifold and black, powdery substance in the area of the O-rings	Loose cylinders. Cylinder motion caused by improper shimming of the discharge manifold	Remove spacer shims on manifold studs. Do not remove too many shims or the ears of the manifold will be bowed when the manifold is retightened, causing looseness in the center cylinder	Strong surging at the inlet and low pressure on the discharge side	Foreign particles in the inlet or discharge valve or worn inlet and/or discharge valves	Check for smooth lap surfaces on inlet and discharge valve seats. Discharge valve seats and inlet valve seats may be lapped on a very fine oil stone; damaged cups and discharge valves cannot be lapped but must be replaced.
Water leakage from under the inlet manifold	Worn inlet manifold seals. Leaking sleeve O-ring	Install seals. If piston rod sleeves are scored, replace sleeves and sleeve O-rings.			
Oil leak between crankcase and pumping section	Worn crankcase piston rod seals	Replace crankcase piston rod seals			
	Excess oil from wicks	Reduce quantity of oil per oiling			
Oil leaking in the area of Crankshaft	Worn crankshaft seal or improperly installed oil seal retainer packing	Remove oil seal retainer and replace damaged gasket and/or seals			
	Bad bearing	Replace bearing			

2. Reduction of Flow.

A. Due to increased length of solution hose.
 NOTE: for every 50 feet of hose, beyond 100 feet in total length, a measurable loss of flow is experienced. This condition is a result of the increased friction experienced by the water as it passes through the hose. Therefore, it is necessary to increase the pressure at the machine 40 PSI for every additional 50 feet of cleaning solution hose over 100 feet.

CHEMICAL PROPORTIONING AND LEVEL CONTROL ILLUSTRATION



CHEMICAL TANK TROUBLESHOOTING

NO OR LOW CHEMICAL FLOW

1. Check that hoses in the tank are secured. Check that the hose from the top of the flow meter to the side of the mix tank is secured with no kinks. Check the hose from the bottom of the flow meter to the chem. Jug for kinks or cracks.
2. Check the foot valve and screen on the end of the hose which goes into the mix tank. To check this screen for proper function, remove it from the plastic hose. You should be able to suck through the hose barb end, but you should not be able to blow through the hose barb end. (If you can not suck through it then rinse it out with vinegar). When screen is removed the chemical fuel hose should be lifted into a vertical position so the ball in the foot valve will seat by gravity. (This is only a temporary fix for low water pressure areas.)
3. Check flow meter for float obstruction.
4. Check to insure that the adjusting screw on proportioning venturi is backed out.
5. Is proportioning venturi closed? Soak in warm water or vinegar solution.
6. Is incoming water pressure less than 20 PSI.?
7. Cracked or defective chemical flow meter?

NOTE: If you are in a low water pressure area and find that the volume of water entering the mix tank is not enough to allow your venturi to siphon chemical, unscrew the spring from the foot valve screen and remove the spring.

INABILITY TO ADJUST CHEMICAL WITH THE FLOW METER

1. Debris lodged behind teflon seat in flow meter knob.
2. Teflon seat dismounting from flow meter knob.

SOLUTION REVERSING FROM MIX TANK TO CHEMICAL JUG

1. Anti-siphon screen removed from chemical jug hose.
2. Debris in anti-siphon screen.

MIX TANK OVERFLOWS

1. Float ball in mix tank hanging up (not moving freely).
2. Extension bracket pinching the float lever, restricting full action of the lever.
3. Plunger not seating properly on the valve. (Remove the 2 screws which hold the extension assembly to the valve. Do not lose or drop the screws. Remove the extension assembly. Turn it upside down. Inspect the plunger for proper seating. If there is no debris obstructing the valve or plunger, the plunger may be out of adjustment. To adjust, loosen the set screw on the ball nut and move the ball toward the end of the rod 1/16". Retighten set screw. Place extension assembly back into position. Tighten the two screws.

MIX TANK DOESN'T KEEP UP WITH WATER OUTPUT

1. Check garden hose quick connect assembly screen.
2. Check garden hose and/or feed hose to the mix tank for clog, kinks or blockage.
3. Float ball in mix tank hanging up. (Not moving freely).
4. Extension bracket pinching float lever, restricting full action of lever.
5. Valve plunger not opening fully. To adjust, remove the 2 screws which hold the extension assembly to the valve. (Do not lose or drop the screws). Remove the extension assembly, turn it upside down. To adjust, loosen the set screw on the ball nut. Place your thumb on the plunger and press it in 1/16" and slide the ball nut w/ set screw toward the plunger end 1/16". Tighten the set screw. Place the extension assembly back into position. If the tank starts to overflow, the ball nut is too close to the valve plunger and should be moved back away from the valve plunger slightly.

PUMP PULSATES WHEN THE TANK IS IN A FILL MODE

1. Check that the hose which goes from the gray plastic venturi to the bottom of the tank is not directed toward the Cat pump pick up port. If it is, aim it in another direction.

HEATING SYSTEM INFORMATION

The propane heater incorporated in this equipment is of special design for use in the carpet cleaning industry. It's high pressure coils and thermostatic temperature control make it simple to operate and reliable. Once the desired temperature is set, the heater will then go 'on' and 'off' according to the water temperature within the heater. As water is used through the cleaning tool, cold water entering the heater will activate the thermostatically controlled propane valve thereby firing the heater to maintain a consistent flow of hot water. Once the cleaning wand is shut off and the flow of water through the heater stops, the heater will continue to burn until the set temperature is attained.

It is possible then with this design that the flame may be on when the wand is off, likewise, it is possible the flame may be off when the wand is on.

CAUTION

This heater is designed to burn vapor propane gas only. Any liquid propane entering the heater may cause damage to the control valve on the heater. It will also cause improper burning and a soot build-up on the coils. Therefore, it is necessary to shut off the heater and close the valve at the tank between cleaning locations. Failure to do this allows sloshing liquid to enter the vapor feed line to the heater.

Overfilling of the propane tank will cause many problems. To avoid this, advise the attendant filling the tank **not to fill the tank over 80%**. When filling the tank, watch the 10% valve and immediately

stop filling when white liquid starts spurting from the 10% valve. To prevent damage to the propane regulator, always close the valve on the tank before filling.

The propane regulator is pre-set at the factory at 6 oz. of propane. This reading is taken at the control valve on the heater (see figure A #6). To prevent road dust and moisture from entering the propane regulator, keep the white tupperware cover (supplied) on the regulator at all times.

To avoid restriction of air flow at base of heater, keep articles such as chemical containers, hose, boxes, etc. from within 18 inches of base of heater. **NOTE:** This restricted situation also creates an over rich condition which results in soot build-up.

IMPORTANT: If a new propane tank has been installed or hoses have been disconnected, air may enter propane hoses and must be purged prior to attempting to light the pilot burner. Should this condition exist, operator must depress the pilot button for 1 - 5 minutes and attempt to ignite the pilot light at 15 second intervals. A very slight hissing noise should be evident while performing this operation.

CAUTION Check heater for propane leaks regularly as loading and unloading hoses, tools, etc., may accidentally bump against heater fittings or pipes.

HEATER - OPERATING INSTRUCTIONS

CAUTION Heater must be filled with water prior to igniting.

A. TO START PILOT:

1. Adjust thermostat control knob on unitrol to desired setting.
2. Adjust upper dial to **pilot** position.
3. Depress pilot button.
4. Depress sparking button to light pilot.

IF PILOT FAILS TO LIGHT:

- Is propane tank full?
- Is propane tank valve open?
- Has air been properly bled from propane line?

WHEN PILOT LIGHTS:

Wait ten seconds, depressing button manually, then release button.

CAUTION Always keep face away from main burner opening to avoid ignition flash.

B. TO LIGHT MAIN BURNER:

1. Turn upper knob to "on" position. Follow instructions as above (TO START PILOT).

If you do not get the burner to flame, the thermostat must turn upper dial to "off" position. Depress the pilot for 60 seconds. To light the main burner, follow instructions as above (TO START PILOT).

OR,

Water may already be at controlled temperature.

Flame will turn off when thermostat senses room temperature.

C. TO ACHIEVE PROPER CARPET CLEANING TEMPERATURE:

1. Complete procedures A & B
2. With 100' of hose, turn cleaning wand on for 5 minutes and the temperature should stabilize.
3. Once a constant temperature is established, turn cleaning wand 'off'. The flame on the heater burner should remain on for 10 - 15 seconds.
 - A. If the flame expires prior to 10 seconds, turn the thermostat dial to a higher reading, then repeat C 1 - 3.
 - B. If the flame remains lit after 15 seconds, turn the thermostat dial to a lower reading, then repeat C 1 - 3.

D. TO SHUT DOWN HEATER:

1. Turn upper dial to 'off' position. (1) Fig. A.

CAUTION

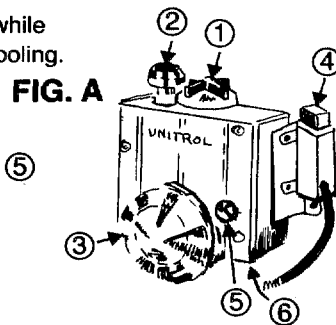
2. Turn cleaning wand on for 3 to 5 minutes to cool heater core. If heater core is not cooled, it is impossible that the heat retained in the core will cause boiling back into the chemical mix tank.

3. Close propane tank valve while wand is on and heater is cooling.

PILOT BURNER ADJUSTMENT

1. Remove pilot adjustment cap (5)
2. Adjust pilot key to provide properly sized flame
3. Replace pilot adjustment cap

ALLEN HEAD PIPE PLUG (6) CAN BE REMOVED FOR MONOMETER INSERTION TO READ PROPANE OUNCES.



HEATER TROUBLESHOOTING

- EXCESSIVE HEAT
- FLAMES PROTRUDING OUTSIDE THE LOWER OPENINGS

CAUSE AND/OR SOLUTION:

1. Thermostatic control dial set too high
 - A. Turn dial to lower setting
2. Maladjustment of propane regulator. **NOTE:** Propane regulators are factory preset and may be readjusted by authorized personnel.
 - A. Contact manufacturer to determine correct procedure.
 - B. Have your local propane dealer use a monometer at the unitrol to re-set the propane regulator to 7 oz. maximum.
3. Overfilled propane tank. **NOTE:** Propane heater is designed to operate on vapor propane only. Over-filling a propane tank allows liquid propane to enter all heater related components and permits an over-rich burning condition to occur. This condition usually requires the heater core to be cleaned of soot and carbon deposits. Cleaning is a messy, dirty job and very inconvenient, so don't let it happen to you!

PROBLEM:

- PILOT LIGHT

CAUSE AND/OR SOLUTION:

1. Pilot light will not ignite. **NOTE:** Do not use a needle or pin to clean pilot orifice - use compressed air or solvent only.
 - A. Verify propane reaching ignitor. **NOTE:** A kinked or crushed hose may impede propane flow.
 - B. Remove and clean orifice.
 - C. Verify ignitor spark is operating correctly.

VACUUM SYSTEM INFORMATION

The vacuum blower incorporated in this machine is a positive displacement lobe type, manufactured by Fuller Company. The performance and life of this unit is greatly dependent on the care and proper maintenance it receives.

Because of the close tolerances between the lobes and housing of the vacuum blower, solid objects entering the inlet will damage the internal lobes, gears and bearing or direct drive coupler.

To prevent this, a stainless steel filter screen has been placed at the vacuum inlet inside the vacuum recovery tank. This stainless steel screen is finger tight and should be removed for cleaning weekly.

CAUTION Should be used when machine is being run for test purpose and the vacuum inlet on top of machine is open.

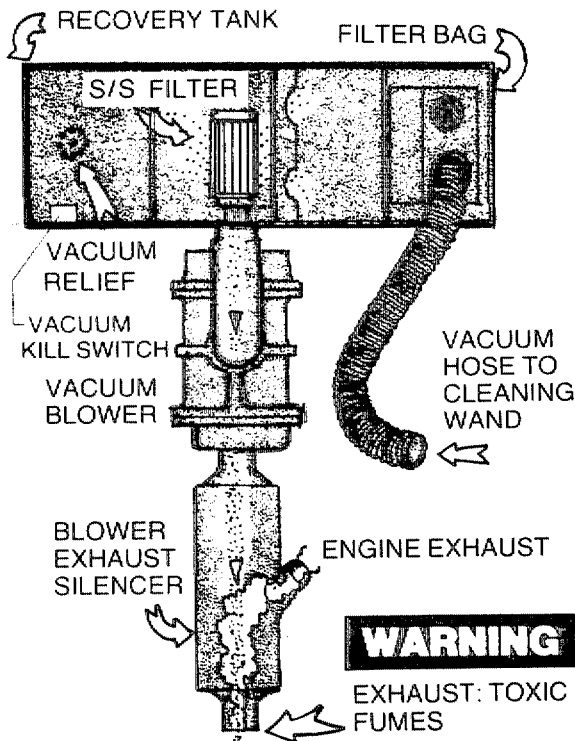
To protect the vacuum blower from over loading and damaging itself, there is a vacuum relief system installed on the vac tank lid. When the vacuum tank inlet is completely sealed off, a maximum of 14 HG will be attained. A hole on the top blower pipe elbow acts as the lubrication point; at the end of each day, LPS 1 or WD-40 is sprayed in before shutting down the machine. See blower lubrication illustration. If you fail to lubricate the vacuum blower daily, rust deposits and moisture will decrease the life of the vacuum blower.

Read the vacuum blower manual carefully for proper oil change and grease application. The maintenance log may differ slightly from the manual, but the truck-mounted carpet cleaning machine application is very demanding of the vacuum blower and therefore it should be maintained more regularly.

NOTICE Vacuum tank is protected from overflowing by a vacuum tank float kill switch.

CAUTION This switch is not activated by foam, only by liquid.

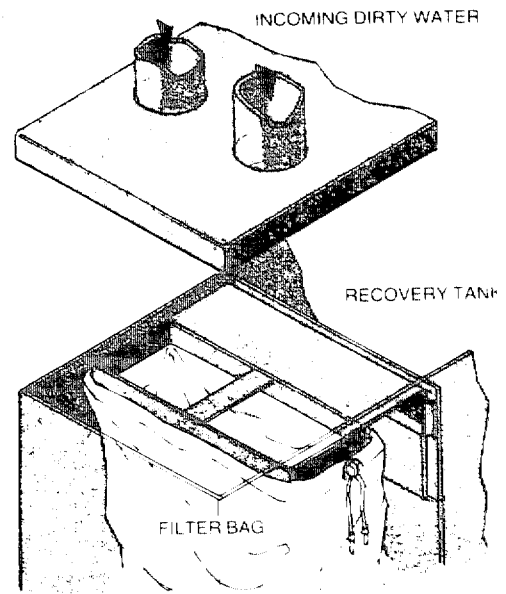
VACUUM FLOW DIAGRAM



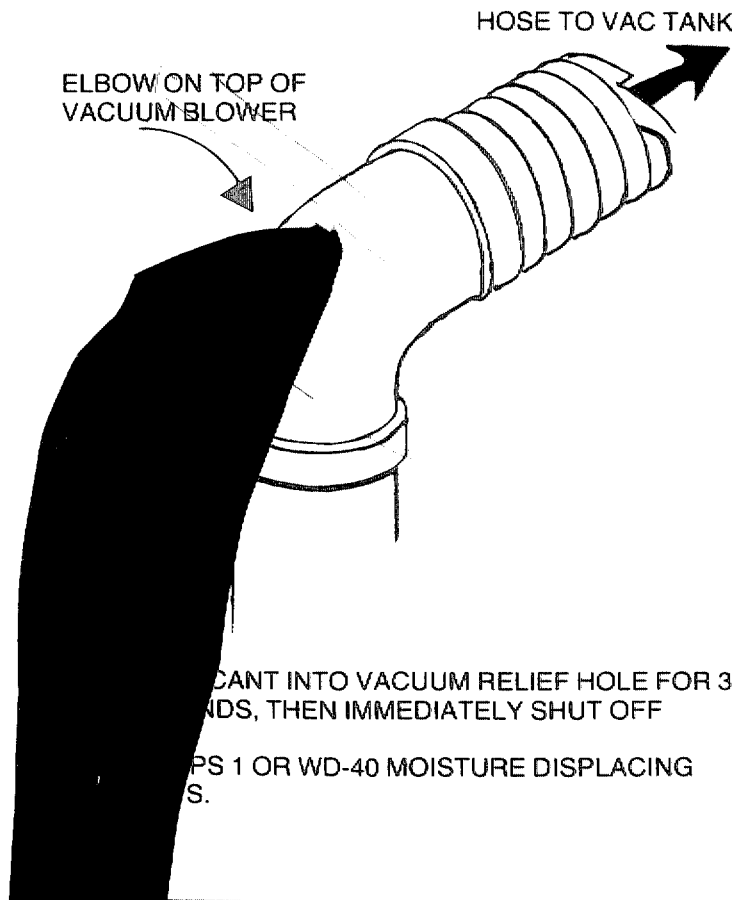
VACUUM TANK FILTER BAGS

Hydra-Master filter bags are designed to trap all of the lint, sand and dirt that would normally collect at the bottom of your vacuum tank. The use of these bags, if emptied at the end of each job, will eliminate the build-up of much of the debris in the tank and avoid a mess on the customer's driveway or street. The drawstring top of these bags is designed to be tied to the incoming dirty water inlet in the vacuum tank.

To re-order bags use part number **049-029**



BLOWER LUBRICANT



WARRANTY

FULLER warrants products of its manufacture to be free from defects in material and workmanship if properly installed, maintained, and operated under normal conditions with competent supervision.

No person, agent, representative or dealer is authorized to give any warranties on behalf of FULLER nor to assume for FULLER any other liability in connection with any of FULLER'S products.

This warranty shall extend for one (1) year from date of installation provided this equipment has been put into service within six months after shipment from the FULLER factory. If repairs or replacements are made by the Purchaser without FULLER'S prior written consent, FULLER'S warranty shall cease to be in effect. No allowance will be granted for any repairs or alterations made by the Purchaser without FULLER'S prior written consent.

Machinery, equipment and accessories furnished by FULLER, but manufactured by others, are warranted only to the extent of the original manufacturer's warranty to FULLER.

FULLER agrees at its option to repair at the point of shipment or to replace without charge f.o.b. point of shipment, any part or parts of products of FULLER'S manufacture, which within the specified warranty period shall be proved to FULLER'S satisfaction to have been defective when shipped, provided the Purchaser promptly notifies FULLER, in writing, of such alleged defect.

FULLER'S liability to Purchaser, whether in contract or in tort arising out of warranties, representations, instructions, or defects from any cause shall be limited to repairing or replacing of the defective part or parts as aforesaid, f.o.b. point of shipment.

No liability whatsoever shall attach to FULLER until said products have been paid for.

EXCEPT AS STATED IN THIS SECTION AND IN THE PRECEDING SECTION TITLED "WARRANTY" AND EXCEPT AS TO TITLE, THERE ARE NO GUARANTEES OR WARRANTIES OF MERCHANTABILITY, FITNESS, PERFORMANCE OR OTHERWISE, EXPRESS, IMPLIED OR STATUTORY, AND FULLER SHALL HAVE NO LIABILITY FOR CONSEQUENTIAL, INCIDENTAL OR OTHER DAMAGES, HOWSOEVER CAUSED.

DATE INSTALLED _____

MODEL _____

SERIAL # _____

FULLER COMPANY
2966 East Victoria Street
Compton, California 90224

FACTORY AUTHORIZED SERVICE CENTERS FOR SUTORBILT PRODUCTS

FULLER COMPANY / COMPTON DIVISION
2966 E. VICTORIA ST., COMPTON, CAL. 90224
213/636-9821 or 639-7600

FULLER COMPANY / MANHEIM DIVISION
236 SOUTH CHERRY STREET
MANHEIM, PENNSYLVANIA 17545
717/665-2224

BAYLISS MACHINE & WELDING CO.
2901 8TH AVENUE NORTH
BIRMINGHAM, ALABAMA 35203
205/323-6121

CAROTEK INCORPORATED
640 SAM NEWELL ROAD
MATHEWS, N. CAROLINA 28105
704/847-4406

BARNEY'S PUMPS INC.
3907 HIGHWAY 98 SOUTH
LAKELAND, FLORIDA 33802
813/686-8195

DYNMAC CORPORATION
7925 E. 40TH STREET
TULSA, OKLAHOMA 74145
918/627-0110

ASSOCIATED TECHNICAL SERVICES, INC.
1229 WAIMANU STREET # 21
HONOLULU, HAWAII 96814
808/537-1206

OLIVER & LAUGHTER EQUIPMENT CO.
10450 WESTOFFICE
HOUSTON, TEXAS 77042
713/977-2577

WM. W. MEYER & SONS
8261 ELMWOOD AVENUE
SKOKIE, ILLINOIS 60076
312/673-0312

ELECTRIC CRAFTS LTD.
3936 EDMONTON TRAIL N.E.
CALGARY, ALBERTA T2E 3P6
403/276-9676

GREGORY-SALISBURY & CO.
805 SOUTH FRONT STREET
NEW ORLEANS, LOUISIANA 70130
504/524-5207

PUMPS & POWER LTD.
1380 NAPIER STREET
VANCOUVER, B.C., CANADA
604/255-4341

SCHWARZ FOUNDRY COMPANY
2001 WEST FORT STREET
DETROIT, MICHIGAN 48216
313/496-1880

GATX-FULLER LTD.
721 PROGRESS AVENUE
SCARBOROUGH, ONTARIO, CANADA
416/438-6540



FULLER COMPANY

A GATX COMPANY

2966 EAST VICTORIA STREET
POST OFFICE, BOX 4308, COMPTON, CALIFORNIA 90224
TEL: (213) 639-7600 (213) 636-9821 TELEX: 67-4607

LUBRICATION

At the gear end the timing gear teeth are lubricated by being partially submerged. The gear teeth serve as oil slingers for gear end bearings. At the drive end the bearings are grease lubricated.

FILLING PROCEDURE

Remove square head vented oil fill plug (A) on gear end. Remove oil level plug (B) located in the head plate. Fill gear case until oil drips out of the oil level hole (B).

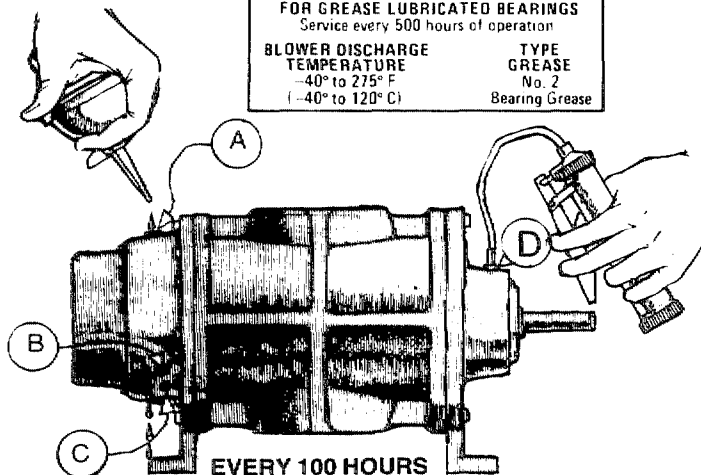
Use lubricants as listed.

Add fresh oil as required to maintain proper level. The oil should be drained, flushed and replaced every 1500 hours or more frequently if inspection so indicates. The oil drain plug is at (C).

NOTE: Older units may have the oil fill level and drain holes located in the cast iron gear case instead of in the head plate.

Bearings on drive end of blower require grease lubrication every 100 hours of operation. Bearings which require grease lubrication will have a grease fitting (D) at each bearing. When regreasing, the old grease will be forced out of the vents during operation. To prevent damage to seals, these vents must be kept open at all times.

LUBRICATION INSTRUCTIONS FOR OIL LUBRICATED GEARS AND BEARINGS		
Add fresh oil as required to maintain proper level. Drain and refill every 1500 hours of operation under normal service, more frequently, when required. Use a good quality oil.		
BLOWER DISCHARGE TEMPERATURE	OIL GRADE U.S.A.*	OIL VISCOSITY, CENTISTOKES @ 40° C
40° to 32° F (4° to 0° C)	SAE 10W	45
32° to 100° F (0° to 38° C)	SAE 20	100
100° to 275° F (38° to 135° C)	SAE 40	200
over 275° F (135° C)	SAE 50	250
*In applications with extreme variations in ambient temperature a 20W/50W multiple viscosity oil is recommended.		
FOR GREASE LUBRICATED BEARINGS		
Service every 500 hours of operation		
BLOWER DISCHARGE TEMPERATURE	TYPE GREASE	
-40° to 275° F (-40° to 120° C)	No. 2 Bearing Grease	



VACUUM BLOWER TROUBLESHOOTING

PROBLEM:

• LOSS OF VACUUM

CAUSE AND/OR SOLUTION:

1. Collapsed vacuum hose between blower and vacuum tank.
 - A. Remove and replace hose. **NOTE:** A special reinforced hose is required for replacement.

2. Clogged stainless steel filter.
 - A. Remove and clean or replace stainless steel filter.
3. Defective vacuum tank seal.
 - A. Remove and replace vacuum tank seal.
4. Defective or 'open' vacuum tank dump valve.
 - A. Close valve.
 - B. Replace valve.
5. Fractured weld on vacuum tank.
 - A. Re-weld as required or replace tank.
6. Collapsed or kinked vacuum hose.
 - A. Reshape hose if possible and/or eliminate kinks.
7. Plugged vacuum hose.
 - A. Remove obstruction by reversing the vacuum hose.
8. Restriction in cleaning tool.
 - A. Remove obstruction.
9. Worn end plates or lobes in vacuum blower.
 - A. Replace worn components. **NOTE:** Must be accomplished by a qualified technician.
10. Loose coupling system between engine and blower.
 - A. The set screws may come loose causing blower to stand still while engine may be turning properly. **NOTE:** Unless the blower is seized or making a knocking noise, your vacuum loss is not caused by a bad blower.

PROBLEM:

• BLOWER IS SEIZED

CAUSE AND/OR SOLUTION:

1. Rust.
 - A. Spray rust dissolving lubricant onto lobes to emulsify rust and attempt to rotate vacuum lobes.
2. Foreign matter.
 - A. Disassemble and remove foreign matter and repair as required. **NOTE:** Disassembly must be accomplished by qualified technician.
3. Seized.
 - A. If you suspect that your blower has seized, remove coupling element, then run engine for a few seconds. This way you won't confuse similar problems.

NOTE: The above mentioned, rust, foreign matter and seizing are often caused from foam traveling through the blower.

PROBLEM:

• NOISE IN VACUUM BLOWER

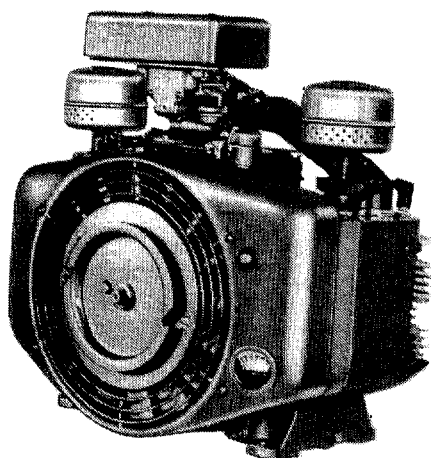
CAUSE AND/OR SOLUTION:

1. Loose Direct Drive Coupler.
 - A. Examine coupler for defects and retighten lock bolts.
 - B. Replace coupler boot if it is either torn or punctured.
2. Worn Gears.
 - A. Remove and replace gears. **NOTE:** Replacement of gears must be accomplished by a qualified technician.
 - B. Timing of vacuum blower has been changed due to worn components. Replacement of components must be accomplished by a qualified technician.
3. Lack of Lubrication. **NOTE:** Permanent damage may have resulted from lack of lubrication.
 - A. Lubricate as specified by applicable vacuum blower manual. See index.
4. Worn bearings
 - A. Remove and replace bearings as required. Must be accomplished by qualified technician.
5. Debris and/or foreign material build-up. **NOTE:** A stainless steel filter is provided in vacuum inlet located in vacuum tank to protect vacuum blower components.
 - A. Disassemble vacuum blower and remove foreign material. **NOTE:** Disassembly should be accomplished by qualified technician only. Replacement of worn parts is recommended if this procedure is necessary.
6. Loose or missing mounting bolts.
 - A. Tighten or reinstall mounting bolts.

Hydra Cat (S/Series)



OPERATING AND MAINTENANCE INSTRUCTIONS



CCKB ENGINE

ONAN

1400 73RD AVENUE N.E. • MINNEAPOLIS, MINNESOTA 55432
A DIVISION OF ONAN CORPORATION

Printed in U.S.A.

FORM NUMBER
927-0151

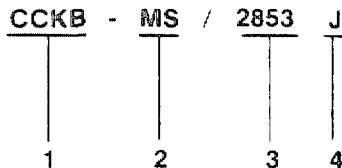
ISSUE DATE
5-77
(SPEC J)

GENERAL INFORMATION

ENGINE MODEL REFERENCE

Identify your model by referring to the MODEL and SPEC (specification) NO. as shown on the unit nameplate. Always use this number and the engine serial number when making reference to your engine.

How to interpret MODEL and SPEC NO.



1. Factory code for general identification purposes.
2. Specific Type:
S - MANUAL STARTING
MS - ELECTRIC STARTING
3. Factory code for optional equipment supplied
4. Specification (Spec Letter) advances with factory production modification.

If your engine needs service or repair, contact an Onan Service Center. Trained mechanics will assure expert repair service on your Onan engine.

SPECIFICATIONS

Engine Design	Opposed two cylinder, four cycle, L head and air cooled
Bore	3-1/4 inch (82.55 mm)
Stroke	3 inch (76.20 mm)
Displacement	49.8 cu inch (816.22 cm ³)
H.P. - Garden Tractor Service	19-1/2 hp @ 3600 rpm; 20 hp max. @ 3900 rpm
Oil Capacity with Filter Change	4 qts. (3.78 lit)
Oil Capacity without Filter Change	3-1/2 qts. (3.31 lit)

TUNE-UP SPECIFICATIONS

Spark Plug Gap (Gasoline)	.025 (0.69 mm)
Spark Plug Gap (LPG)	.018 (0.46 mm)
Breaker Point Gap	.020 (0.51 mm)
Valve Lash:	
Intake	.006 to .008 (0.152 to 0.203 mm)
Exhaust	.015 to .017 (0.381 to 0.432 mm)
Ignition Timing:	
Standard Electric Start (Stopped or Running)	20° BTC
Manual Start with Spark Advance	1° ATDC (Stopped) 24° BTC (Running)
Electric Start with Magneto and Spark Advance	5° (Stopped) 24° BTC (Running)

OUT-OF-SERVICE PROTECTION

Protect an engine that will be out-of-service for more than 30 days as follows.

1. Run engine until thoroughly warm (5 to 10 minutes).
2. Turn off fuel supply and run until engine stops.
3. Drain oil from oil base while still warm. Refill and attach a warning tag stating oil viscosity used.
4. Remove spark plugs. Pour one ounce (two tablespoons) of rust inhibitor (or SAE #50 oil) into the cylinders. Crank engine over a few times. Install spark plugs.
5. Service air cleaner.
6. Clean governor linkage and protect by wrapping with a clean cloth.
7. Plug exhaust outlet to prevent entrance of moisture, dirt, bugs, etc.
8. Wipe entire unit. Coat rustable parts with a light film of grease or oil.
9. Provide a suitable cover for the entire unit.
10. If battery is used, disconnect and follow standard battery storage procedure.

RUNNING REPLACEMENT PARTS

Oil Filter	122-0323
Air Filter	140-0636
Spark Plugs—Non-Resistor	167-0241
Spark Plugs—Resistor	167-0237
Breaker Points	160-0002
Condenser (Breaker Box)	312-0069
Coil	166-0535

WARNING

ENGINE EXHAUST GAS (CARBON MONOXIDE) IS DEADLY!

Carbon monoxide is an odorless, colorless gas formed by incomplete combustion of hydrocarbon fuels. Carbon monoxide is a dangerous gas that can cause unconsciousness and is potentially lethal. Some of the symptoms or signs of carbon monoxide inhalation are:

- Dizziness
- Intense Headache
- Weakness and Sleepiness
- Vomiting
- Muscular Twitching
- Throbbing in Temples

If you experience any of the above symptoms, get out into fresh air immediately.

The best protection against carbon monoxide inhalation is a regular inspection of the complete exhaust system. If you notice a change in the sound or appearance of exhaust system, shut the unit down immediately and have it inspected and repaired at once by a competent mechanic.

PRE-START

BEFORE STARTING

Check the engine to make sure it has been filled with oil and fuel. The chart below lists oil and fuel recommendations.

Crankcase Oil: Fill the crankcase with a good quality oil that meets the API (American Petroleum Institute) service designation SE or SE/CC. Recommended oil numbers for expected ambient temperatures are as follows:

TEMPERATURE	GRADE
Below 0° F (18° C)	SAE 5W30
Below 32° F (0° C)	SAE 5W30 or 10W40
Above 32° F (0° C)	SAE 30

Fill to "Full" mark on dipstick.

CAUTION

Do not overfill crankcase. Do not use service DS oil. Do not mix brands nor grades of motor oil.

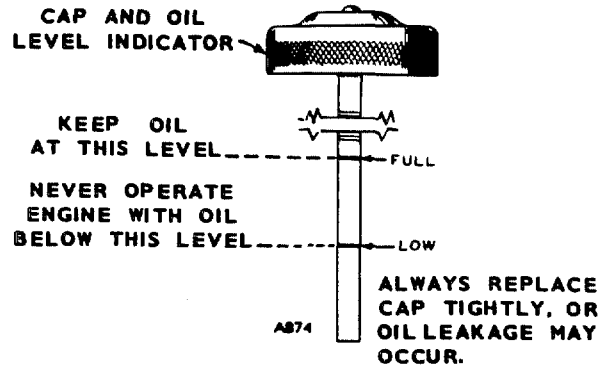
Refer to *Periodic Service* section for recommended oil change intervals.

Recommended Fuel: Use clean, fresh, non-leaded or regular grade, automotive gasoline. Do not use highly leaded premium types.

For new engines, the most satisfactory results are obtained by using nonleaded gasoline. For older engines that have previously used leaded gasoline, heads must be taken off and all lead deposits removed from engine before switching to nonleaded gasoline.

WARNING

Never check oil level while engine is running. Hot oil discharged from the engine could cause personal injury.



CRANKCASE OIL FILL

CAUTION

If lead deposits are not removed from engine before switching from leaded to nonleaded gasoline, preignition could occur, causing severe damage to the engine.

WARNING

Never fill the fuel tank when the engine is running. Gasoline could ignite, causing a serious injury.

Inspection: Inspect the engine visually before starting. Check for loose or missing parts and any damage which may have occurred in shipment.

STARTING

If your engine has a START-RUN-STOP switch, press switch toggle to START, then release to RUN when engine starts. Press toggle to STOP, to stop engine.

1. Turn on ignition switch, pull the choke lever way out (for a cold engine) and push the start switch. When the engine starts, gradually push the choke lever in until the engine runs smoothly.
2. Black smoke from the exhaust and a rough running engine usually indicate over-choking.
3. To stop engine, turn ignition switch to off position.

OPERATION

BREAK-IN PROCEDURE

Controlled break-in with proper oil and a conscientiously applied maintenance program will help assure satisfactory service for many hours from your Onan engine.

Break-in or ideal fitting of all internal moving metal parts can best be achieved by maintaining proper cooling and correct lubrication during the running-in period. Run the engine at about half load for the first three hours with intermittent periods of full load to control engine break-in. Engine damage can be caused by using the wrong grade and weight of oil and high engine operating temperatures during break-in.

Check the oil level at least every five operating hours. Add oil to keep it at the proper level, but never overfill as overfilling may cause the oil to foam and enter the breather system.

HOT WEATHER OPERATION

When operating the engine in temperatures above 75°F (24°C) pay particular attention to the following items to prevent damage:

1. Keep the engine cooling fins clean and free of

obstruction which would decrease air flow to and from the engine.

2. See that nothing obstructs air flow to and from the engine.
3. Ensure that you are using the proper grade and weight of oil for the temperature the engine is being used in. Check the oil level each time you fill the fuel tank.
4. Check the battery water level more frequently than every 50 hours which is recommended under normal conditions. High temperatures cause faster evaporation.

COLD WEATHER OPERATION

When the engine is being used in temperatures below 32°F (0°C) check the following items closely

1. Use the correct grade and weight of oil for the temperature conditions. Change the oil only when the engine is warm. If an unexpected temperature drop occurs when the engine is filled with summer oil, move to a warm location until the oil will flow freely before starting the engine.
2. Use fresh fuel. Fill the fuel tank after each days use to protect against moisture condensation.
3. Keep battery in a well-charged condition.

MAINTENANCE

Oil Level: Check oil level at least every eight hours of operation. Check more frequently on a new or overhauled engine as oil consumption is higher until piston rings seat properly.

Oil Change: Change crankcase oil after the first 25 hours of operation; change every 50 hours after that. If operating in extremely dusty conditions, change oil more frequently.

Oil Filter (If Used): Replace oil filter every 100 hours; replace more often in dusty conditions. Tighten the filter finger-tight plus one quarter to one half turn. Be sure to replace rubber ring around filter.

Crankcase Breather: This engine uses a crankcase breather valve for maintaining crankcase vacuum. No maintenance is generally required. If the crankcase becomes pressurized as evidenced by oil leaks at the seals, clean the crankcase breather cap and valve assembly, and the breather tube baffle in suitable solvent. To remove breather cap and valve assembly, remove the breather hose clamp and breather tube clamp.

Moistened Foam Air Cleaner: This air cleaner consists of a synthetic sponge over a metal retainer. The base and cover are similar to those of the dry paper kind. Wash the sponge periodically, moisten in oil and squeeze dry.

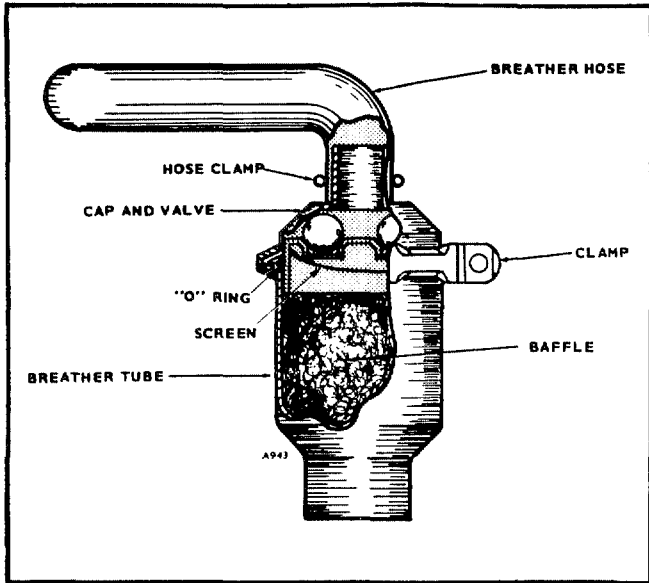
Cooling System: Check and clean cooling fins at least every 50 hours. Remove any dust, dirt or oil which may have accumulated.

CAUTION

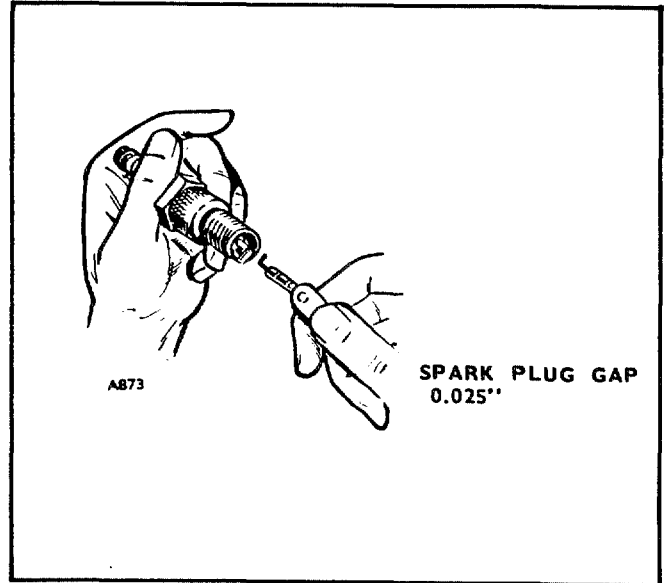
Plugged or clogged cooling fins can cause overheating and engine damage.

Spark Plugs: Check, clean and reset spark plugs every 100 operating hours. Replace spark plugs that show signs of fouling or electrode erosion. Replace plugs every 250 operating hours.

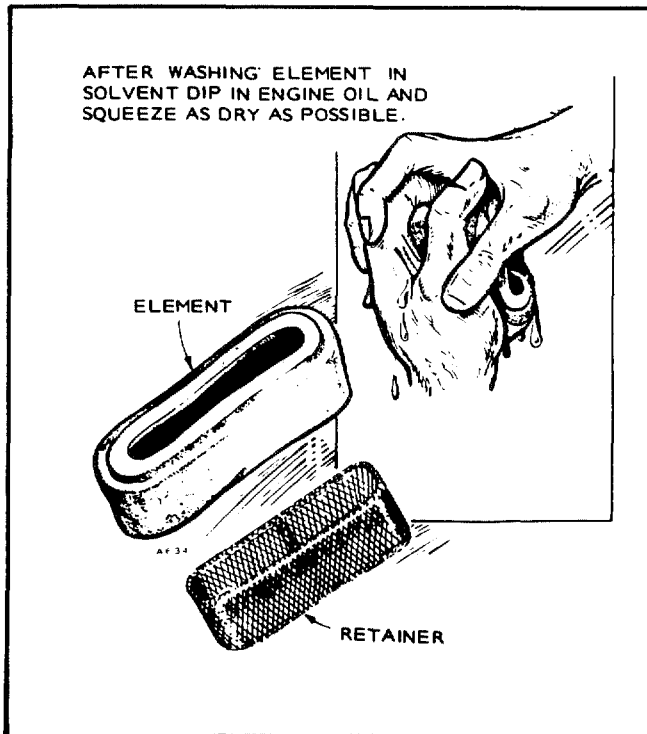
Breaker Points: Check, clean and reset breaker points every 200 operating hours. Replace points if they are pitted or burned. See *ADJUSTMENT* section.



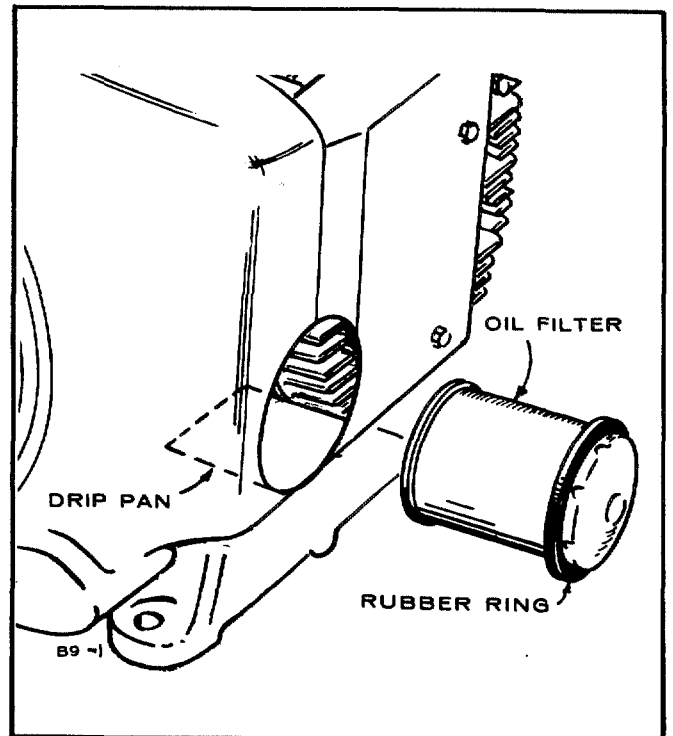
CRANKCASE BREATHER



SPARK PLUG GAP



AIR CLEANER



OIL FILTER

ADJUSTMENTS

CARBURETOR

The carburetor has an idle jet and a main jet. The idle jet which is adjustable, affects engine operation at low speed. The main jet usually affects operation under load (high speed). Under normal circumstances, factory carburetor adjustments should not be disturbed. If the idle adjustment has been disturbed, turn the needle (counterclockwise) off its seat 1 to 1-1/2 turns to permit starting the engine, then readjust as follows:

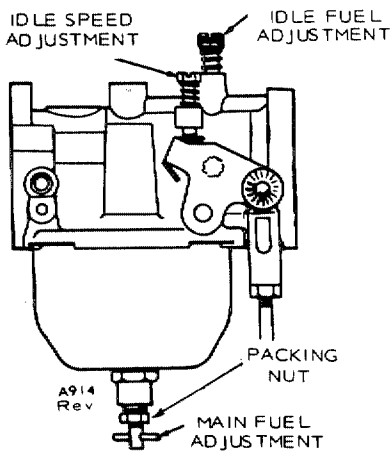
Carburetor Idle Adjustment

1. Allow the engine to run at least 10 minutes to warm it up.
2. Move engine speed control to SLOW position. The engine should run at about 1300 rpm.
3. Turn the idle needle out (counterclockwise) until engine begins to slow down or run unevenly. Remember this position.
4. Turn needle in (clockwise) past the position where the engine runs smoothly until it begins to slow down or run unevenly.

CAUTION Do not force the needle against its seat; doing so will damage it.

5. Back the needle out to a position approximately halfway between the two positions. This should provide a smooth running idle.

CAUTION Loosen the packing nut before making main fuel adjustment and then tighten the nut to a snug fit after the adjustment has been made. This procedure makes it easier to use the carburetor adjusting tool and prevents fuel leaks around the packing nut. Fuel leaks cause hard starting because the float level becomes lower than normal.



CARBURETOR

CARBURETOR ADJUSTMENTS

Carburetor Main (Load) Adjustment

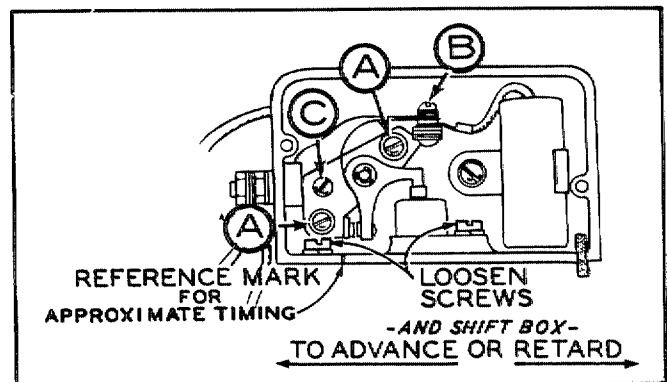
If engine runs unevenly at half or full load due to faulty carburetion, the main adjusting needle needs readjustment. For initial start-up, turn main adjustment 1 to 1-1/2 turns (counterclockwise) off its seat.

1. Start engine and allow it to warm up.
2. Push in on the governor mechanism to slow the unit down to about 400-500 rpm.
3. Set idle adjustment so engine runs smoothly.
4. Release governor mechanism to allow engine to accelerate. If engine accelerates evenly and without hesitation, main adjustment is correct. If not, turn needle outward about 1/2 turn and again slow the engine down and release the mechanism. Continue until the engine accelerates evenly and without hesitation after releasing the governor.
5. If engine tends to hunt (alternate increase and decrease of speed), open the main adjusting needle a little more. Do not open more than 1/2 turn beyond the maximum power point.

BREAKER POINTS

To maintain maximum efficiency from the engine, check condition of the breaker points every 200 hours of operation. Proceed as follows:

1. Remove the two screws and the cover on the breaker box.
2. Remove both spark plugs so engine can be easily rotated by hand. If plugs have not been changed within the last 100 hours, clean and regap or replace them with new ones after setting the breaker points.
3. Remove the two mounting screws (A) and pull the points out of the box just far enough so screw (B) can be removed. Replace points with a new set (if needed) but do not completely tighten mounting screws (A).
4. Rotate the engine clockwise (facing flywheel) by hand until TC mark on gear cover aligns with TC mark on flywheel. Turn screw (C) until point gap measures .020" (0.508 mm) with a flat thickness gauge.
5. Tighten mounting screws and recheck gap.



BREAKER POINT ADJUSTMENT

PERIODIC SERVICE GUIDE

Regularly scheduled maintenance is the key to lower operating costs and longer service life for the unit. The following schedule can be used as a guide. However, actual operating conditions under which a unit is run should be the determining factor in establishing a maintenance schedule. When operating in very dusty or dirty conditions, some of the service periods may have to be reduced. Check

the condition of the crankcase oil, the filters, cooling fins, etc. frequently until the proper service time periods can be established.

For any abnormalities in operation, unusual noises from engine or accessories, loss of power, overheating, etc., contact your nearest Onan Service Center.

PERIODIC MAINTENANCE SCHEDULE

SERVICE THESE ITEMS	AFTER EACH CYCLE OF INDICATED HOURS					
	8	50	100	200	400	1000
Inspect Engine Generally	x ³					
Check Oil Level	x					
Service Air Cleaner		x ¹				
Change Crankcase Oil		x ¹				
Check Battery Electrolyte Level		x				
Clean Cooling Fins		x				
Clean and Regap Spark Plugs (Replace at 250 hours)			x			
Replace Oil Filter			x ¹			
Clean Breather Valve				x		
Check Breaker Points				x		
Replace Air Cleaner Element				x ¹		
Check Valve Clearance					x ²	
Remove Carbon and Lead Deposits					x ²	
Inspect Valves, Grind If Necessary						x ²
Complete Reconditioning (If Required)						x ²

x¹ - Perform more often in extremely dusty conditions.

x² - For detailed maintenance, contact an Onan Service Center.

x³ - Check for fuel leaks, exhaust leaks, etc.

**FOR MAJOR SERVICE AND
OVERHAUL CONTACT YOUR
NEAREST ONAN SERVICE
CENTER.**

ENGINE SAFETY PRECAUTIONS

It is recommended that you read your engine manual and become thoroughly acquainted with your equipment before you start the engine.

WARNING This symbol is used throughout this manual to warn of possible serious personal injury.

CAUTION This symbol refers to possible equipment damage.

Fuels, electrical equipment, batteries, exhaust gases and moving parts present potential hazards that could result in serious, personal injury. Take care in following these recommended procedures.

Safety Codes

- All local, state and federal codes should be consulted and complied with.

General

- Provide appropriate fire extinguishers and install them in convenient locations. Use an extinguisher rated ABC by NFPA.
- Make sure that all fasteners on the engine are secure. Tighten supports and clamps, keep guards in position over fans, driving belts, etc.
- If it is necessary to make adjustments while the engine is running, use extreme caution when close to hot exhausts, moving parts, etc.

Protect Against Moving Parts

- Do not wear loose clothing in the vicinity of moving parts, such as PTO shafts, flywheels, blowers, couplings, fans, belts, etc.
- Keep your hands away from moving parts.

Batteries

- Before starting work on the engine, disconnect batteries to prevent inadvertent starting of the engine.
- **DO NOT SMOKE** while servicing batteries. Lead acid batteries give off a highly explosive hydrogen gas which can be ignited by flame, electrical arcing or by smoking.
- Verify battery polarity before connecting battery cables. Connect negative cable last.

Fuel System

- **DO NOT** fill fuel tanks while engine is running, unless tanks are outside engine compartment.

- **DO NOT** smoke or use an open flame in the vicinity of the engine or fuel tank. Internal combustion engine fuels are highly flammable.
- Fuel lines must be of steel piping, adequately secured, and free from leaks. Piping at the engine should be approved flexible line. Do not use copper piping on flexible lines as copper will work harden and become brittle enough to break.
- Be sure all fuel supplies have a positive shutoff valve.

Exhaust System

- Exhaust products of any internal combustion engine are toxic and can cause injury, or death if inhaled. All engine installations, especially those within a confine, should be equipped with an exhaust system to discharge gases to the atmosphere.
- Do not use exhaust gases to heat a compartment.
- Make sure that your exhaust system is free of leaks. Ensure that exhaust manifolds are secure and are not warped by bolts unevenly torqued.

Engine Exhaust Gas (Carbon Monoxide) is Deadly!

Carbon monoxide is an odorless, colorless gas formed by incomplete combustion of hydrocarbon fuels. Carbon monoxide is a dangerous gas that can cause unconsciousness and is potentially lethal. Some of the symptoms or signs of carbon monoxide inhalation are:

- Dizziness
- Vomiting
- Intense Headache
- Muscular Twitching
- Weakness and Sleepiness
- Throbbing in Temples

If you experience any of the above symptoms, get out into fresh air immediately.

The best protection against carbon monoxide inhalation is a regular inspection of the complete exhaust system. If you notice a change in the sound or appearance of exhaust system, shut the unit down immediately and have it inspected and repaired at once by a competent mechanic.

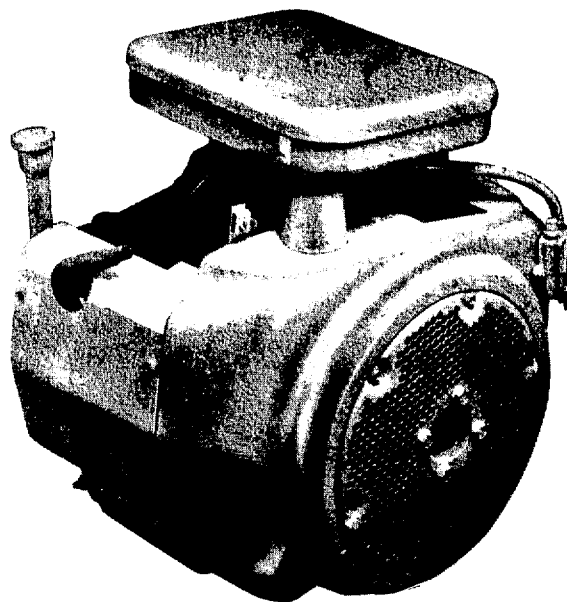
Cooling System

- Coolants under pressure have a higher boiling point than water. **DO NOT** open a radiator pressure cap while the engine is running. Bleed the system pressure first.

Keep the Unit and Surrounding Area Clean

- Make sure that oily rags are not left on or near the engine.
- Remove all oil deposits. Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and subsequent engine damage and may present a potential fire hazard.

Hydra-Cat (L/Series) Engine Set-Up/ (20 B.H.P. B48G, Onan Engine)



Inspect the engine visually. Check for loose or missing parts and any damage that may have occurred in shipment.

CAUTION *Oil, fuel, and coolant have been drained from the engine prior to shipping from Onan.*

BATTERIES

The batteries and battery cables used for starting the engine should be of sufficient size to provide prompt starting. Undersized batteries will result in poor starter operation and a very short starter service life.

WARNING *Do not smoke while servicing batteries. Explosive gases are emitted from batteries while charging. Ignition of these gases can cause severe personal injury.*

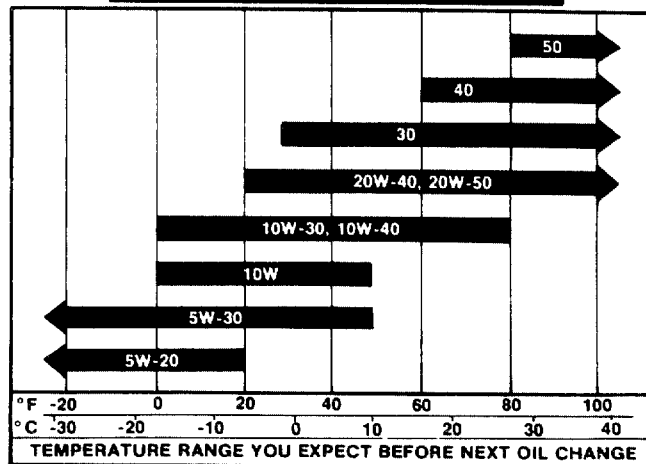
CRANKCASE OIL RECOMMENDATIONS

Fill crankcase with correct amount of oil. Refer to *SPECIFICATIONS* for crankcase capacity. Use oils meeting the American Petroleum Institute (API) classification SE or SE/CC.

WARNING *Do not check oil while the engine is operating. Hot oil could cause burns by blowing out of the oil fill, due to crankcase pressure.*

CAUTION *Do not overfill crankcase. Excess oil causes higher operating temperatures and may cause foaming.*

USE THESE SAE VISCOSITY GRADES



Oil Level

Check oil level at least every 8 hours of operation. Check more frequently on a new or reconditioned engine as oil consumption is higher until the piston rings seat properly.

When adding oil between oil changes, it is preferable to use the same brand, as various brands of oil may not be compatible together. Refer to *MAINTENANCE* section for recommended oil change intervals and procedures.

FUEL RECOMMENDATIONS

WARNING *Do not permit any flame, cigarette, or other igniter near the fuel system. Fuel is highly flammable and potentially explosive and could result in severe personal injury or death.*

Use clean, fresh, unleaded or regular grade gasoline. Do not use highly leaded premium fuels. Using unleaded gasoline results in less maintenance.

Use regular gasoline for the first 25 hours to allow the rings to seat well for best performance. Then use unleaded or regular gasoline thereafter.

If regular gasoline is used continually, carbon and lead deposits must be removed from the cylinder heads as required because of engine power loss. Unleaded gasoline may be used safely after lead deposits have been removed.

CAUTION *Failure to remove lead deposits prior to use of unleaded fuel can cause pre-ignition and possible engine damage.*

WARNING *Never fill the fuel tank when the engine is running. Fuel could ignite and cause serious personal injury or death.*

EXHAUST SYSTEM

Exhaust products of any internal combustion engine are toxic and can cause injury, or death if inhaled. All engine applications, especially those within a confined area, should be equipped with an exhaust system to discharge gases to the outside atmosphere.

WARNING *Use extreme care during exhaust system installation to ensure a tight exhaust system. Exhaust gases are deadly.*

WARNING *Inhalation of exhaust gases can result in serious personal injury or death.*

Operation

STARTING

Most engines are equipped with a start-stop switch and cable controlled choke and throttle.

1. Place the throttle control in the *SLOW* position and the choke into the *FULL* choke position.
2. Turn the ignition switch on and engage starter. If engine fails to start after 30 seconds determine the cause. Wait one minute before re-igniting.

If the engine fails to start at first attempt, rust inhibitor oil used at the factory may have fouled the plugs. Remove the plugs, clean in a suitable solvent, dry thoroughly and reinstall. Heavy exhaust smoke when the engine is initially started is normal and usually caused by rust inhibitor oil.

3. When the engine starts, gradually push the choke lever in until the engine runs smoothly.
4. Black smoke from the exhaust and a rough running engine usually indicate over-choking.
5. To stop the engine, turn the ignition switch to the *OFF* position.

BREAK-IN PROCEDURE

Controlled break-in is the ideal fitting of all internal moving metal parts. Using the proper oil and applying a conscientious maintenance program during this period helps assure satisfactory service from your Onan engine.

Maintain the proper cooling and lubrication during break-in. Run the engine at half load for the first three hours with intermittent periods of full load to control engine break-in.

CAUTION *Using the wrong grade and weight of oil and high engine operating temperatures during break-in can cause engine damage.*

Check the oil level at least every five operating hours. Add oil to keep it at the proper level, but never overfill as overfilling may cause the oil to foam and enter the breather system.

HOT WEATHER OPERATION

When operating the engine in temperatures above 100° F (38° C), pay particular attention to the following items to prevent damage:

1. Keep the engine cooling fins clean and free of obstruction.

CAUTION *Plugged or clogged cooling fins can cause overheating and engine damage.*

WARNING *Contact with rotating machinery might cause serious personal injury or death. Stay clear of rotating components and ensure that protective shields and guards are in place and secured before operating machinery.*

2. See that nothing obstructs air flow to and from the engine.
3. Ensure that you are using the proper grade and weight of oil for ambient temperatures. Check the oil level each time you fill the fuel tank.
4. Check the battery water more frequently than every 50 hours which is recommended under normal conditions. High temperatures cause faster evaporation.
5. Change crankcase oil and filter more frequently than recommended under normal conditions.

COLD WEATHER OPERATION

When the engine is being used in temperatures below 32° F (0° C), check the following items closely:

1. Use the correct grade and weight of oil for the temperature conditions. Change the oil only when the engine is warm. If an unexpected temperature drop occurs when the engine is filled with summer

oil, before starting the engine, move it to a warm location until the oil will flow freely.

2. Use fresh fuel. Fill the fuel tank after each day's use to protect against moisture condensation.
3. Keep the battery in a well-charged condition.

DUST AND DIRT

1. Keep unit clean. Keep cooling system clean.
2. Service air cleaner as frequently as required.
3. Change crankcase oil and filter more often than recommended under normal conditions.

OUT-OF-SERVICE PROTECTION

Protect an engine that will be out-of-service for more than 30 days as follows:

1. Run the engine until it reaches normal operating temperature.
2. Turn off the fuel supply and run the engine until it stops.
3. Drain oil from oil base while the engine is still warm. Refill with fresh crankcase oil and attach a tag stating viscosity used.
4. Remove spark plugs. Pour 1 ounce (2 tablespoons or 28 grams) of rust inhibitor of SAE #50 oil into the cylinders. Crank the engine over a few times. Reinstall spark plugs.
5. Service air cleaner as outlined in *MAINTENANCE* section.

6. Clean governor linkage and protect by wrapping with a clean cloth.
7. Plug exhaust outlet to prevent entrance of moisture, dirt, bugs, etc.
8. Wipe entire unit. Coat rustable parts with a light film of grease or oil.
9. Provide a suitable cover for the entire unit.
10. If battery equipped, disconnect and follow standard battery storage procedure.

RETURNING UNIT TO SERVICE

1. Remove cover and all protective wrapping. Remove plug from exhaust outlet.
2. Check tag on oil base and verify that oil viscosity is still correct for existing ambient temperatures.
3. Clean and check battery. Measure specific gravity (1.260 at 77°F [25°C]) and verify level to be at split ring. If specific gravity is low, charge until correct value is obtained. If the level is low, add distilled water and charge until specific gravity is correct. *DO NOT OVERCHARGE.*
4. Check that fuel filter and fuel lines are secure, with no leaks.
5. Check carburetor, adjust if necessary.
6. Connect battery.
7. Start engine.

After engine has started, excessive blue smoke is exhausted until the rust inhibitor has burned away.

WARNING

EXHAUST GAS IS DEADLY!

Exhaust gases contain carbon monoxide, a poisonous gas that might cause unconsciousness and death. It is an odorless and colorless gas formed during combustion of hydrocarbon fuels. Symptoms of carbon monoxide poisoning are:

- ***Dizziness***
- ***Headache***
- ***Weakness and Sleepiness***
- ***Vomiting***
- ***Muscular Twitching***
- ***Throbbing in Temples***

If you experience any of these symptoms, get out into fresh air immediately, shut down the unit and do not use until it has been inspected.

The best protection against carbon monoxide inhalation is proper installation and regular, frequent inspections of the complete exhaust system. If you notice a change in the sound or appearance of exhaust system, shut the unit down immediately and have it inspected and repaired at once by a competent mechanic.

WARNING Before commencing any maintenance work on the engine, control panel, or associated equipment, disconnect batteries. Failure to do so could result in damage, or serious personal injury in the event of inadvertent starting.

DAILY CHECKS OR EVERY 8 HOURS

The operator should daily make a complete visual and audible inspection of the engine. Check the following before starting the engine for the first time each day:

1. Check all fuel lines and fittings for possible leakage.
2. Inspect exhaust system for possible leakage and cracks. Locate leaks in muffler and piping while the engine is operating. Repair all leaks immediately after they are detected for personnel safety.
3. Inspect air cleaner system for leaks. Make certain that all clamps and fittings are tight and free of potential leaks.
4. Check crankcase oil level with the engine off. If oil level is at or below "add" mark on dipstick (Figure 1), add sufficient oil of the proper viscosity as specified in the *ENGINE SET-UP* section to bring oil level to the full mark on the dipstick. Do not operate engine with oil level below the "add" mark.

Allow a minimum of 10 minutes for the oil to drain down before checking. The best time to check the oil is after an overnight shut-down period.

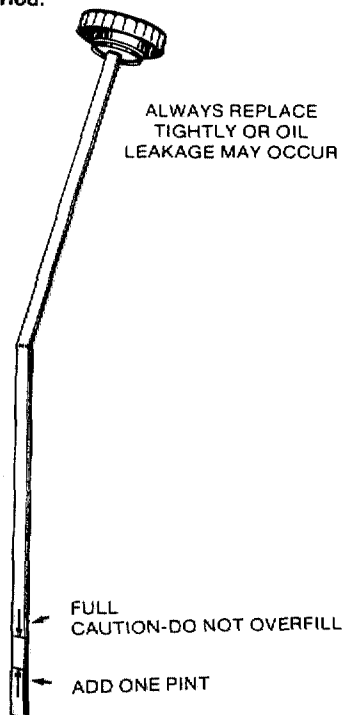


FIGURE 1. CRANKCASE OIL FILL

OIL CHANGE

Change crankcase oil after the first 25 hours of operation, and every 50 hours thereafter. If operating in extremely dusty, high ambient, or low ambient conditions change oil more often.

Run engine until thoroughly warm before draining oil. Stop the engine, place a pan under the drain outlet and remove the oil drain plug or open the drain valve. After the oil is completely drained, replace the drain plug or close the drain valve. Refill with oil of the correct API classification and appropriate SAE viscosity grade for the temperature conditions (refer to *ENGINE SET-UP* section).

WARNING Hot crankcase oil can cause burns if it is spilled or splashed on skin. Keep fingers and hands clear when removing the oil drain plug and wear protective clothing.

Oil level should be to the "full" mark of the dipstick. Start engine and run for a short time to check for oil leaks around the drain plug.

OIL FILTER CHANGE

Replace oil filter (Figure 2) after the first 25 hours of operation, and every 100 hours thereafter. If operating in extremely dusty, high ambient, or low ambient conditions change oil filter more often.

Spin off oil filter element and discard it. Thoroughly clean filter mounting surface and install new element, making sure new gasket is inserted in the element. Apply a thin film of oil to the gasket. Spin element down by hand until gasket just touches mounting pad and then turn down an additional 1/4-1/2 turn. Do not overtighten.

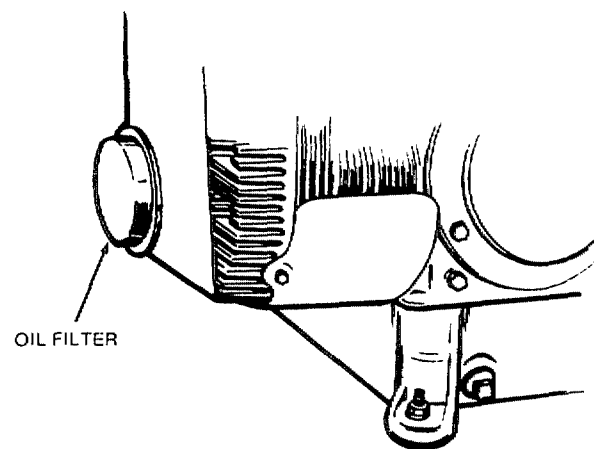


FIGURE 2. OIL FILTER CHANGE

With oil in crankcase, start engine and check for leaks around filter element. Retighten only as much as necessary to eliminate leaks, but do not overtighten.

IGNITION

Spark Plugs

Check, and regap spark plugs every 100 hours of operation (Figure 3). Replace spark plugs that show signs of fouling or electrode erosion.

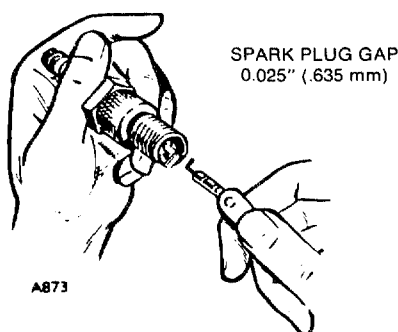


FIGURE 3. SPARK PLUG GAP

Breaker Points

Check breaker points every 100 hours. Replace points and condenser every 200 operating hours. Replace sooner if points are pitted or burned. See *ADJUSTMENTS* section.

COOLING SYSTEM

Check and clean cooling fins and chaff screen at least every 50 hours. Remove any dust, dirt or oil which may have accumulated. See *SERVICE MANUAL* (965-0757) if removal of cylinder air housing is required.

BATTERIES

Disconnect negative ground strap from the battery before working on any part of the electrical system or engine.

Disconnect positive terminals before charging batteries to avoid damaging alternator or regulator.

WARNING

Do not smoke while servicing batteries. Explosive gases are emitted from batteries while charging. Ignition of these gases can cause severe personal injury.

Cleaning Batteries

Keep the batteries clean by wiping them with a damp cloth whenever dirt appears excessive.

If corrosion is present around the terminal connections, remove battery cables and wash the terminals with an ammonia solution or a solution consisting of 1/4 pound of baking soda added to 1 quart of water.

Be sure the vent plugs are tight to prevent cleaning solution from entering the cells.

After cleaning, flush the outside of the battery, the battery compartment, and surrounding areas with clear water.

Keep the battery terminals clean and tight. After making connections, coat the terminals with a light application of petroleum jelly or non-conductive grease to retard corrosion.

Checking Specific Gravity

Use a battery hydrometer to check the specific gravity of the electrolyte in each battery cell.

Hold the hydrometer vertical and take the reading. Correct the reading by adding four gravity points (0.004) for every five degrees the electrolyte temperature is above 80°F (27°C) or subtracting four gravity points for every five degrees below 80°F (27°C). A fully charged battery will have a corrected specific gravity of 1.260. Charge the battery if the reading is below 1.215.

Checking Electrolyte Level

Check the level of the electrolyte (acid and water solution) in the batteries at least every 50 hours of operation.

Fill the battery cells to the bottom of the filler neck. If cells are low on water, add distilled water and recharge. If one cell is low, check case for leaks. Keep the battery case clean and dry. An accumulation of moisture will lead to a more rapid discharge and battery failure.

CAUTION

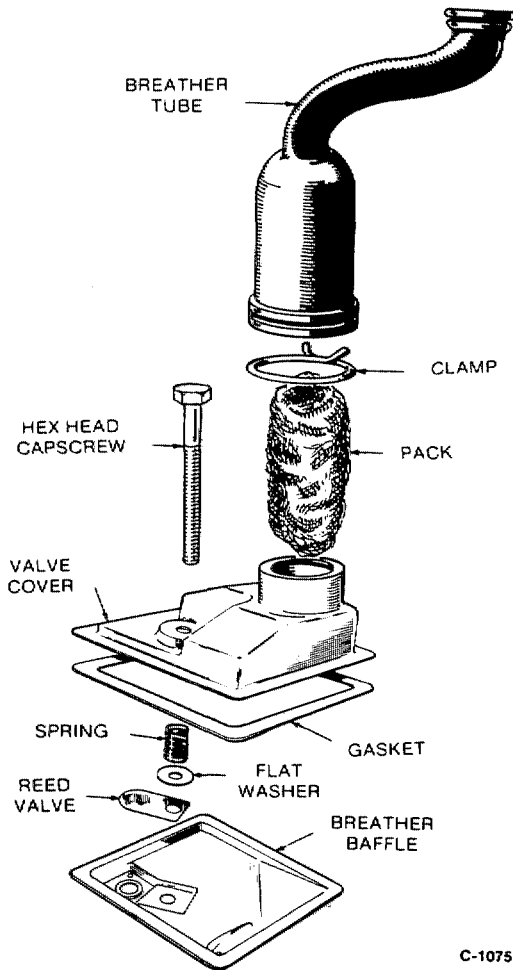
Do not add water in freezing weather unless the engine is to be run long enough (two or three hours) to assure a thorough mixing of water and electrolyte.

Storing Batteries

If the engine is to be stored for more than 30 days, remove the batteries. With the electrolyte level at the bottom of the split ring, charge the battery before storing it. After every 30 days the battery is in storage, bring it back up to full charge. To reduce self-discharge, store the battery in as cool a place as possible so long as the electrolyte does not freeze.

CRANKCASE BREATHER

34 This engine uses a crankcase breather valve and "Pack" for maintaining crankcase vacuum. If the crankcase becomes pressurized as evidenced by oil leaks at the seals, clean pack and valve in a suitable solvent. Check and clean valve and baffle every 200 hours of operation. See Figure 4.



C-1075

FIGURE 4. CRANKCASE BREATHER

EXHAUST SYSTEM

Make regular visual and audible inspections of the exhaust system throughout the entire life of the engine. Locate leaks in muffler and piping while the engine is operating. Repair all leaks immediately after they are detected for personnel safety.

WARNING Check exhaust system frequently for leaks. Be sure deadly exhaust gases are piped to outside. Inhalation of exhaust gases can result in serious personal injury or death.

AIR CLEANER

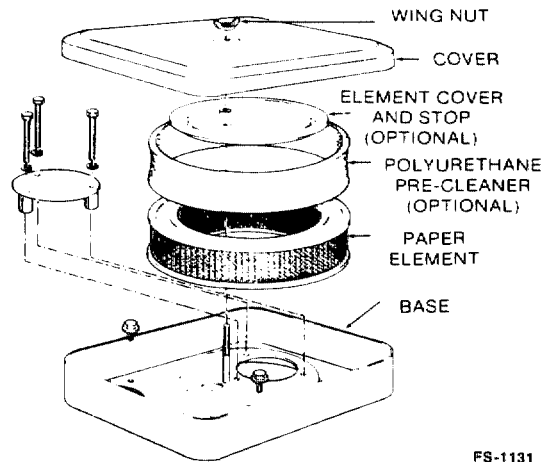
Cartridge Air Cleaner

Check and clean air cleaner element every 25 hours (Figure 5). Clean by gently tapping element on a flat surface. Replace the element every 200 hours. Clean or replace more frequently in dusty operating conditions.

Air Cleaner Wrapper (Pre-Cleaner [if used])

Wash in water and detergent and squeeze dry like a sponge (Figure 5). Allow to dry, then coat evenly with two tablespoons (28 grams) of SAE 30 engine oil. Knead into and wring excess oil from pre-cleaner. Reinstall over cartridge.

Failure to adequately wring out excess oil from the wrapper may cause drop in engine horsepower due to an increased restriction of inlet air.



FS-1131

1. WASH
2. SQUEEZE DRY
3. COAT WITH OIL
4. INSTALL OVER PAPER ELEMENT



FIGURE 5. AIR CLEANER ASSEMBLY

PERIODIC MAINTENANCE SCHEDULE

Follow a regular schedule of inspection and servicing, based on operating hours (see *Periodic Maintenance Schedule*). Keep an accurate logbook of maintenance, servicing, and operating time. Use the factory recommended Periodic Maintenance Schedule (based on favorable operating conditions) to serve as a guide to get long and efficient engine life. Regular service periods are recommended for normal service and operating conditions. For continuous duty, extreme

temperature, etc., service more frequently. For infrequent use, light duty, etc., service periods can be lengthened accordingly. Neglecting routine maintenance can result in engine failure or permanent damage.

For any abnormalities in operation, unusual noises from the engine or accessories, loss of power, overheating, etc., contact your nearest Onan Service Center.

PERIODIC MAINTENANCE SCHEDULE

SERVICE THESE ITEMS	AFTER EACH CYCLE OF INDICATED HOURS				
	8	25	50	100	200
Inspect Engine Generally	X ¹				
Check Oil Level	X				
Service Air Cleaner		X ²			
Change Crankcase Oil		X ³	X ²		
Check Battery Electrolyte Level			X		
Clean Cooling Fins			X ²		
Replace Oil Filter		X ³		X ²	
Check or Replace Spark Plugs				X	
Check Breaker Points				X	
Replace Points and Condenser					X
Clean Breather Valve					X ²
Replace Air Cleaner Element					X ²
Check Valve Clearance			X ³		X ⁴
Compression Check					X ⁴
Clean Carbon and Lead Deposits (Cylinder Head)					X ^{4,5}

X¹ - Check for fuel leaks. With engine running, visually and audibly check exhaust system for leaks.

X² - Perform more often when running under severe operating conditions.

X³ - Initial break-in check only.

X⁴ - For detailed maintenance, contact an Onan Service Center or refer to the 965-0757 SERVICE MANUAL.

X⁵ - For engines running on unleaded fuel this interval may be extended to 400 hours.

WARNING All exhaust system connections **MUST** be checked regularly (visually and audibly) for leaks and repaired as necessary. Do NOT use the air cleaner/ flame arrestor or exhaust elbow as a supporting step as it could cause an exhaust leak. Inhalation of exhaust gases can result in serious personal injury or death.

CARBURETOR

The carburetor idle and main mixture were set for maximum efficiency at the factory and should normally not be disturbed. If adjustments seem necessary, first be sure the ignition system is working properly and is not the source of the problem.

If adjustment is needed, refer to Figures 6 and 7 and proceed as follows:

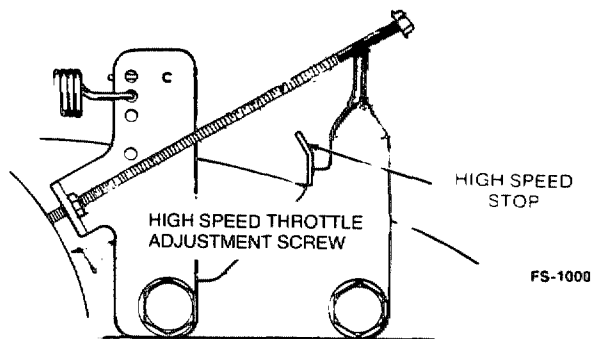
1. Turn idle mixture screw in until lightly seated, then back idle mixture screw out $3/4$ turn. On engines equipped with optional main fuel adjustment, turn main mixture screw in until lightly seated then back the main mixture screw out $1-1/4$ to $1-1/2$ turns.

CAUTION Forcing the mixture adjustment screw tight will damage the needle and seat. Turn in only until light tension can be felt.

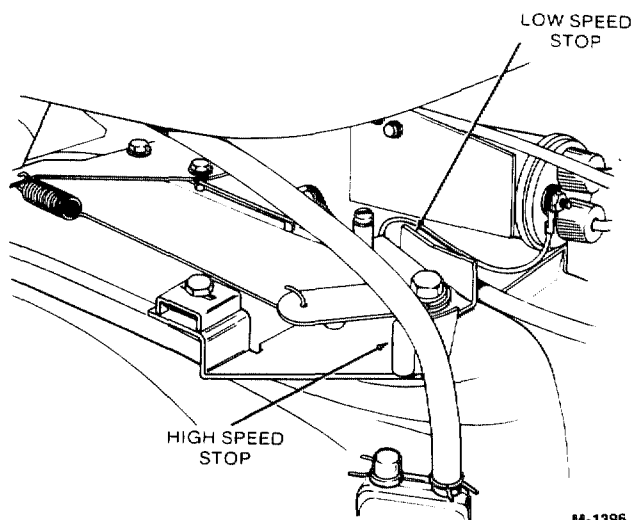
2. Start the engine and allow it to warm up thoroughly (at least 10 minutes).

Some equipment manufacturer's may require higher throttle stop speed and governor low speed rpm settings. Refer to equipment manufacturer's Operator's Manual for the correct rpm settings. When rpm settings are not specified by the equipment manufacturer use the rpm settings listed in Steps 3 and 5.

3. Move the engine speed control to the slow position. Bend or turn the low speed stop on the governor so that the throttle stop screw on the carburetor controls engine speed. Adjust the throttle stop screw for 1000 rpm idle.
4. Determine the best idle mixture setting by first turning the idle adjustment screw in until engine speed drops and then outward until engine speed drops again. Over a narrow range between these two settings, engine speed remains at its highest. Set the adjustment screw about $1/8$ turn outward (rich) from the midpoint of this range.
5. Readjust the throttle stop screw for 1000 rpm idle, then adjust the governor low speed stop for 1100 rpm idle.
6. Move the engine speed control to the fast position. Bend the high speed stop on the governor so the engine runs at the vehicle manufacturer's recommended speed.



SIDE PULL GOVERNOR ASSEMBLY



FRONT PULL GOVERNOR ASSEMBLY

FIGURE 6. GOVERNOR SPEED ADJUSTMENT

7. Optional main fuel adjustment:

Check the main mixture adjustment by rapidly accelerating the engine from idle to full speed. The engine should accelerate evenly and without hesitation. If it does not, turn the main adjustment screw out in $1/8$ turn increments until the engine accelerates smoothly, but do not turn it out more than $1/2$ turn beyond the original setting.

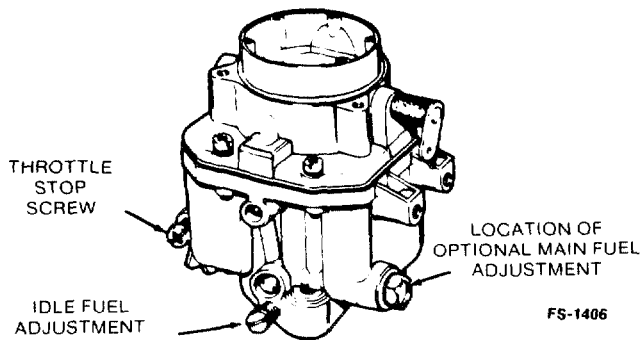


FIGURE 7. CARBURETOR ADJUSTMENTS

BREAKER POINTS

The timing is adjusted during initial engine assembly and is fixed by the point gap adjustment. To maintain maximum engine efficiency, change the breaker points every 200 hours of operation.

Replacement and Adjustment

1. Remove spark plugs.
2. Remove breaker box cover. Rotate crankshaft clockwise (facing flywheel) until points are fully open.
3. Remove condenser (screw A) and detach condenser lead and coil lead (screw B). See Figure 8.
4. Remove two Allen screws (C) and lift breaker assembly from engine.
5. Replace condenser and point assembly with new parts and reinstall using above procedure in reverse order of removal.
6. Adjust point gap by rotating crankshaft clockwise (facing flywheel) by hand until the points are fully open. Set the point gap (using flat feeler gauge) at .016 inch (0.41 mm) by adjusting the Allen screw (D) inward or outward (Figure 9). A .016 point gap is equivalent to 16° BTC.

Make sure feeler gauge is clean and free of any grease, oil or dirt.

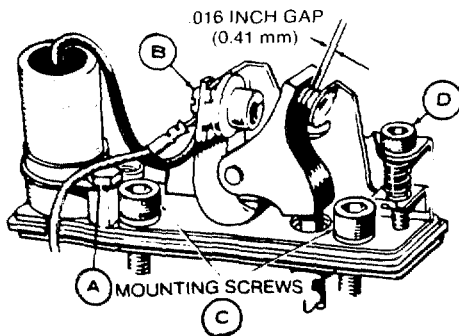


FIGURE 8. SETTING POINT GAP

7. Replace breaker box cover, coil wire, spark plugs, and spark plug cables.

Continuity Test

As a check for proper ignition timing a continuity test may be performed:

1. Adjust breaker points.
2. Remove blower housing to expose timing marks on top of gearcase cover and flywheel (Figure 9).

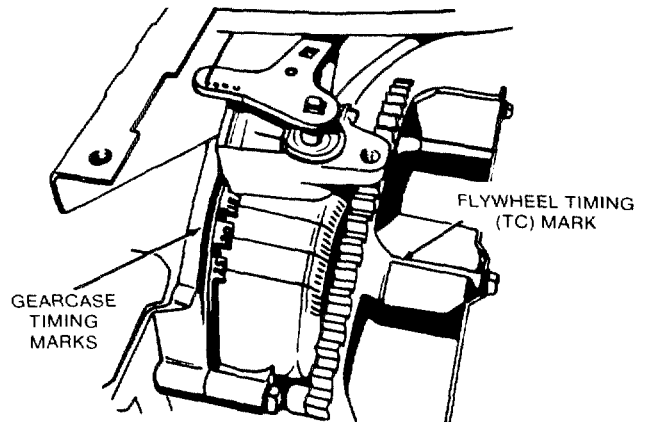


FIGURE 9. TIMING MARKS

M-1397

3. Rotate flywheel clockwise until timing mark is aligned with the mark corresponding to 16° BTC on top of gearcase cover.
4. Connect an ohmmeter or a continuity test lamp set across the ignition breaker points. Touch one test prod to the coil lead terminal (screw B Figure 8).
5. Touch the other test prod to a good ground on the engine.
6. Turn crankshaft against rotation (counterclockwise) until the points close. Then slowly turn the crankshaft with rotation (clockwise).
7. The lamp should go out or continuity lost just as the points break which is where ignition occurs. If timing is early (advanced) the point gap is too large. If timing is late (retarded) the point gap is too small. Adjust point gap accordingly.



**INDUSTRIAL ENGINES
U.S. AND CANADA**

38

Onan extends to the first retail customer of engines, the following warranty covering engines manufactured or supplied by Onan, subject to the qualifications indicated.

THERE IS NO OTHER EXPRESS WARRANTY.

IMPLIED WARRANTIES INCLUDING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE LIMITED TO PERIODS OF WARRANTY SET FORTH BELOW, AND TO THE EXTENT PERMITTED BY LAW, ANY AND ALL IMPLIED WARRANTIES ARE EXCLUDED.

IN NO EVENT IS ONAN LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES

Note: Some states do not allow limitations on how long an implied warranty lasts or do not allow the exclusion of incidental or consequential damages, so the above limitations may not apply to you.

- (1) Onan warrants to the first retail customer for the periods set forth below that engines manufactured by Onan will be free from defects in workmanship and material, provided these engines are installed, operated, and maintained in accordance with Onan's written instructions.

PRODUCT APPLICATION

- Engines used in commercial-industrial, personal, family, and household applications.
- Engines used in automotive on-highway vehicles.
- Engines used in rental and demonstration applications.
- Engines used in irrigation.
- Repair or replacement parts.

PERIOD OF WARRANTY

- One (1) year from date of purchase.
- One (1) year from date of purchase or twelve thousand (12,000) miles, whichever occurs first.
- One (1) year from date of first rental or demonstration.
- Six (6) months from date of purchase or first season.
- Ninety (90) days from date of purchase.

- (2) Onan's sole liability and Purchaser's sole remedy for a failure of engine under this warranty and for any and all other claims arising out of the purchase and use of the engine, including negligence on the part of the manufacturer, shall be limited to the repair of the product by the repair or replacement, at Onan's option, of parts that do not conform to this warranty, provided that the product or parts are returned to Onan's factory at 1400 73rd Avenue NE, Minneapolis, Minnesota 55432, or to an Onan Authorized Engine Distributor or its designated service representative, transportation prepaid.

- (3) Onan will pay the following for removal and reinstallation of an Onan engine from a retail customer's application, when removal and reinstallation is required to perform warranty repair work on the engine, provided the work is performed by an Authorized Onan Engine Distributor or its designated service representative.

Engine

- One (1) or two (2) cylinders.
- Three (3), four (4), or six (6) cylinders.

Time Allowed

- Two (2) hours.
- Four (4) hours.

- (4) Onan will pay the following for travel time and mileage on diesel engines, provided the work is performed by an Authorized Onan Engine Distributor or its designated service representative.

Engine

- Three (3), four (4), or six (6) cylinders

Travel Allowance

- Six and one half (6.5) hours and two hundred and fifty (250) miles (402 kilometers).

- (5) All claims must be brought to the attention of Onan or an Authorized Onan Engine Distributor or its designated service representative within thirty (30) days after discovery that the engine or parts fail to meet this warranty.
- (6) THIS WARRANTY SHALL NOT APPLY TO:

- a) Cost of maintenance, adjustments, installation, and start-up
- b) Failures due to normal wear, accident, misuse, abuse, negligence, improper installation, or lack of reasonable and necessary maintenance.
- c) Products which are altered or modified in a manner not authorized by manufacturer in writing
- d) Failure of engine caused by defects in the system or application in which the engine is installed.
- e) Telephone, telegraph, teletype, or other communication expenses.
- f) Living and travel expenses of persons performing service, except as specifically provided in Section 4
- g) Rental equipment used while warranty repairs are being performed.
- h) Overtime labor requested by purchaser.
- i) Travel time and mileage for one (1) and two (2) cylinder engines.
- j) Travel time, mileage, and labor for removal and reinstallation of spare parts under ninety (90) day warranty
- k) Countries outside of the U.S. and Canada.

No person is authorized to give any other warranties or to assume any other liabilities on Onan's behalf, unless made or assumed in writing by an officer of Onan.

- (7) This warranty gives the user specific legal rights, and the user may also have other rights which vary from state to state.

ENGINE

An engine instruction brochure is included with this manual (see index) which may assist you in resolving engine related problems.

PROBLEMS:

- ENGINE FAILS TO START
- ENGINE RUNS ROUGH
- ENGINE BACKFIRES
- ENGINE FAILS TO ACCELERATE
- ENGINE REDUCES SPEED TO LOW RPM UNDER LOAD

CAUSES AND/OR SOLUTION:

1. Loss of fuel
 - A. Empty gas tank.
 - B. Plugged fuel line or filter.
 - C. Defective fuel pump. (Replace with mfg. suggested replacement parts only).
 - D. Gas line kinked, crushed or quick disconnect inside the truck not connected.
2. Blown master fuse.
 - A. Electrical short.
 - B. Defective fuse.
3. Worn or maladjusted points (Onan eng. Only) (Briggs has electronic ignition).
 - A. Remove and replace points and condenser.
 - B. Clean and adjust points.
4. Defective spark plugs
 - A. Remove and replace.
 - B. Clean and regap.
5. Defective spark plug wires
 - A. Spark plug wires along with many others may, at certain points come in contact with heated parts (exhaust manifold) or abrasive parts (sharp metal, teflon hose). This may be taken into consideration for electrical shorts.
 - B. Remove and replace.
6. Low compression
 - A. Defective valve.
 - B. Stuck valve.
 - C. Worn compression rings.
 - D. Defective piston.
7. Float switch in recovery tank inoperative. **NOTE:** Temporary repair permits disconnection of float switch wire between tank and machine. Continued operation with this condition will compromise vac blower.
 - A. Switch stuck on upright position by foreign material.
 - B. Defective float switch.
8. Engine will not turn over
 - A. Dead battery
 - B. Loose terminal connection on battery or ignition switch.
 - C. Defective starter.
 - D. Seized engine or blower.
9. Defective Carburetor or gas leakage.
 - A. Clean carb.
 - B. Replace carb.
 - C. Choke locked in closed position.

CAUTION

- D. When replacing fuel pump insure that it is the same pressure rating recommended by mfg.
10. Improperly adjusted carb. **NOTE:** A comprehensive manual is available and defines necessary adjustments.
 - A. Incorrect air mixture ratio adjustment.
 - B. Incorrect float level adjustment.
11. Carbon build-up in cylinders. **NOTE:** Carbon build-up can be minimized by using unleaded regular gas. Should carbon removal be necessary, reinstall heads with new gaskets.

- A. Carbon build-up may be excessive if carb. or valves are improperly adjusted, engine RPM too low, improper spark plug gap.
- B. Remove cylinder heads and eliminate carbon build-up with wire brush.
12. Incorrect timing
 - A. Timing may become offset if point box is not secure or if points are out of adjustment. (Onan only).
13. Dirty air cleaner
 - A. If exhaust gaskets do not seat properly or heat exchanger gasket is bad, exhaust may heat and melt the the air cleaner requiring much clean-up repair.
14. Clogged fuel filter
 - A. Remove and replace
15. Low oil level or malfunctioning oil pump
 - A. Oil pressure sensors can be installed on the engine. This will eliminate many problems which may occur.
16. Vacuum tank full
 - A. Empty vacuum tank

ELECTRICAL SYSTEM

The entire electrical system operates on 12 volts DC which is provided by a battery. Battery levels are sustained by a 7 amp alternator designed within the engine.

NOTE: When new battery is installed insure it is properly charged before installation or damage to the charging regulator may occur.

PROBLEM:

• LOW BATTERY VOLTAGE

CAUSE AND/OR SOLUTION:

1. Defective battery
 - A. Remove and replace.
2. Corroded battery terminals
 - A. Clean terminals and battery posts.
3. Low battery fluid
 - A. Add water to appropriate level.
4. Loose wiring within electrical system
 - A. Examine all terminal connections and verify that they are secure. **NOTE:** Give special attention to ignition switch terminals.

5. Blown charging fuse
 - A. Remove and replace fuse.
 - B. Check battery charge.
 - C. Check battery cells with hydrometer.
6. Electrical short in wiring system
 - A. Examine electrical systems for bare wires.
7. Poor ground connection
 - A. Examine terminal and remove corrosion if necessary.
 - B. Follow ground wire from (-) of battery to where it grounds at the frame. If it is grounded to painted steel then scratch some of the paint off to allow for circuit to be completed through the steel.

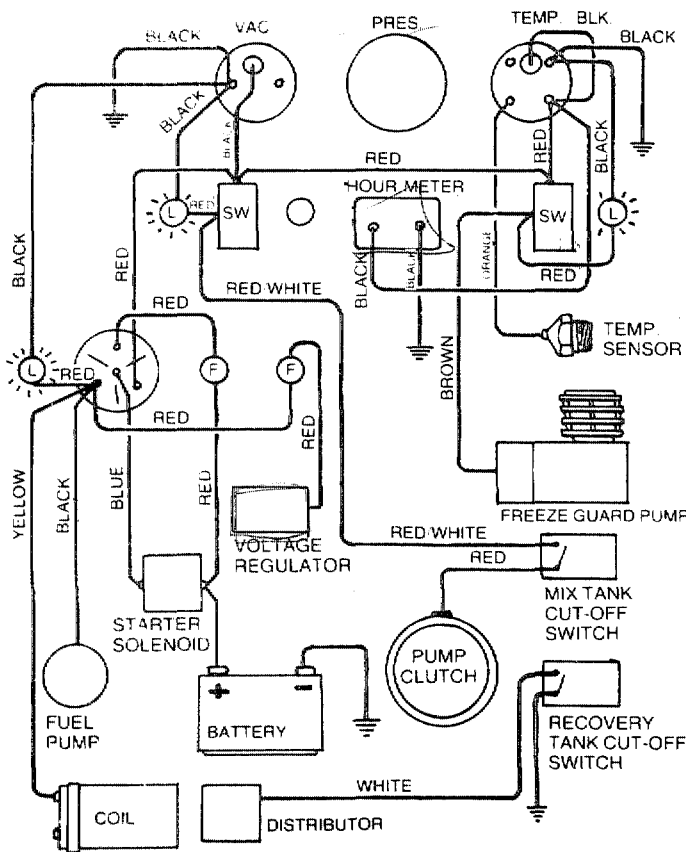
INOPERATIVE HOUR METER

CAUSE AND/OR SOLUTION:

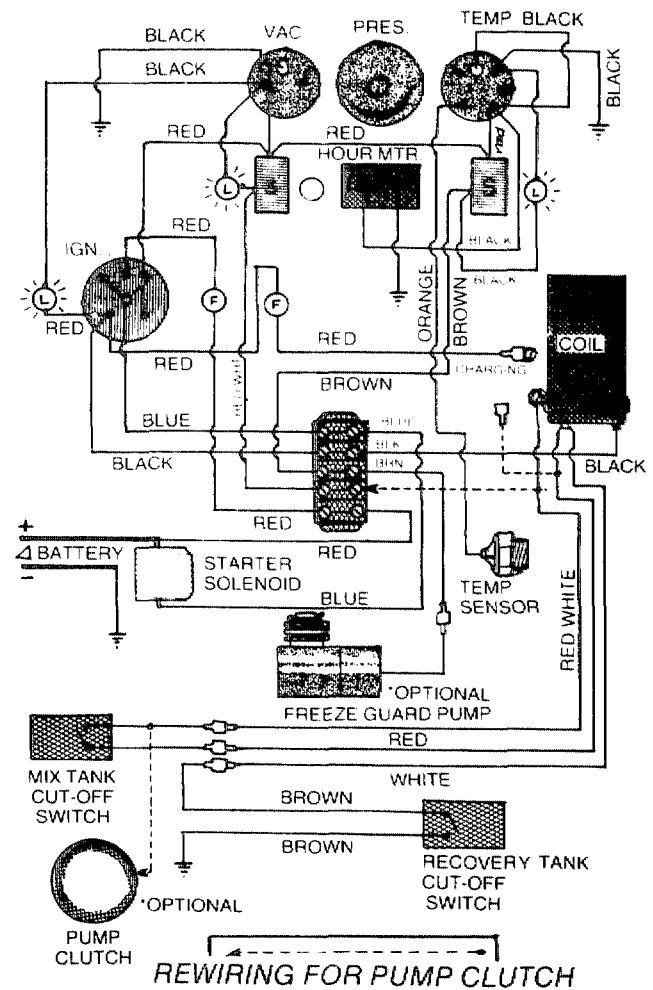
1. Time is not advancing correctly
 - A. Verify 12 volts DC is available at the hour meter with the ignition switch turned on. This can be accomplished with a volt meter or a test lamp.
 - B. Remove and replace hour meter if 12 volts is available.
 - C. A nylon gear within the clock may have been jammed due to a sudden jolt of the machine or truck. You may try simply tapping on the meter to try to free the nylon gear.

ELECTRICAL DIAGRAM

HYDRA-CAT
S/Series

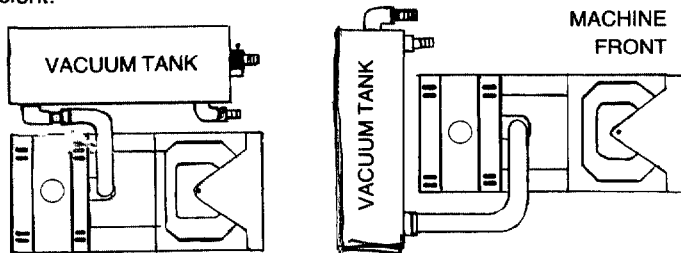


HYDRA-CAT
L/Series



MACHINE INSTALLATION INFORMATION

There are two ways of positioning the machine in the truck as shown on the following page. There are also two locations for the vacuum recovery tank to be positioned. First, the standard way with the tank directly alongside the machine. Second, with the tank across the back of the machine as shown below; this location is most space efficient.



Whichever way you select, make sure the tank and machine are secured to the floor of the van to insure driver safety.

It is important that the machine be placed as close to the door as possible so that outside air can be pulled into the engine for proper cooling.

WARNING It is recommended by the manufacturer that the exhaust from the front of the machine be vented down under the truck to prevent carbon monoxide from entering the job site. Always park the truck so the exhaust is blowing away from the job site.

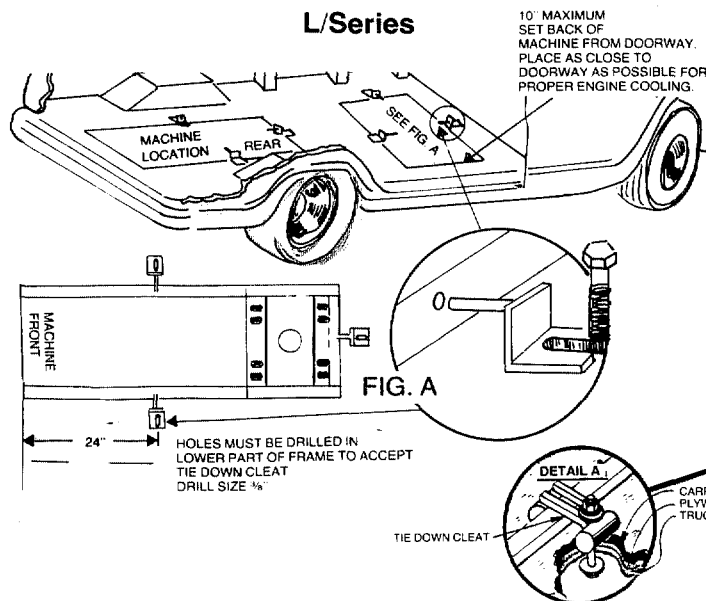
The manufacturer also recommends that installation of aluminum vents in the truck roof to allow heat from the heater to escape.

WARNING Never operate this machine with a portable propane tank or a portable gas can inside the truck. The heater is an open flame type and could cause a fire or explosion.

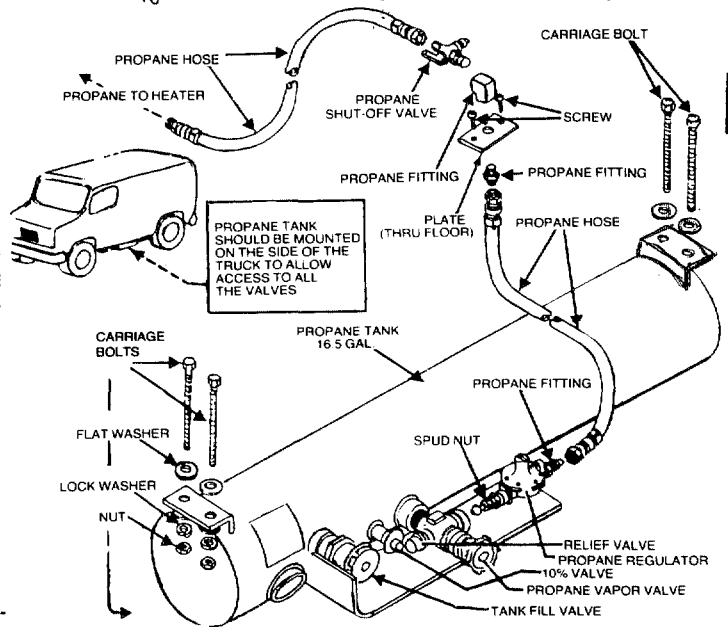
Mount a fire extinguisher just inside the rear or side door for emergencies.

MACHINE TIE DOWN CLEAT ILLUSTRATION

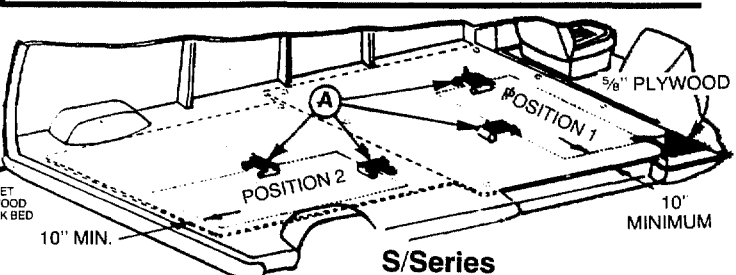
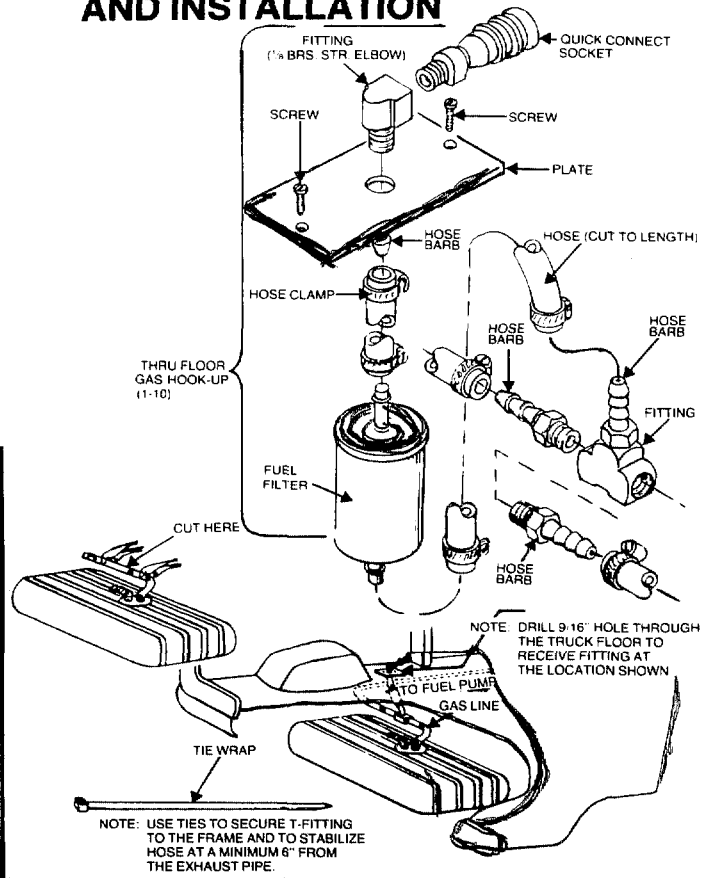
L/Series



PROPANE TANK PLUMBING



THRU-FLOOR GAS HOOK-UP AND INSTALLATION



WATER SOFTENER

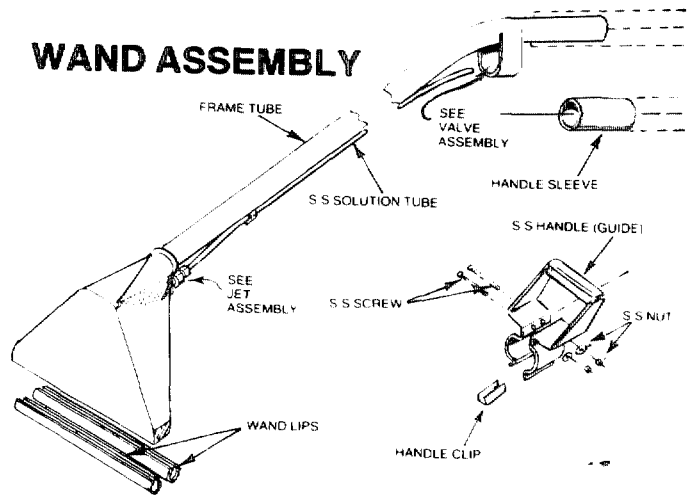
Many areas of the country have an excess of minerals in the water which results in what is commonly called "hard water". These minerals tend to adhere to the insides of heater coils and other parts of the machines causing damage and a loss of cleaning effectiveness.

Reports from several of our machine users commending the results of the use of water softeners in conjunction with their machines prompts us to recommend the procedure to everyone in a "hard water" area.

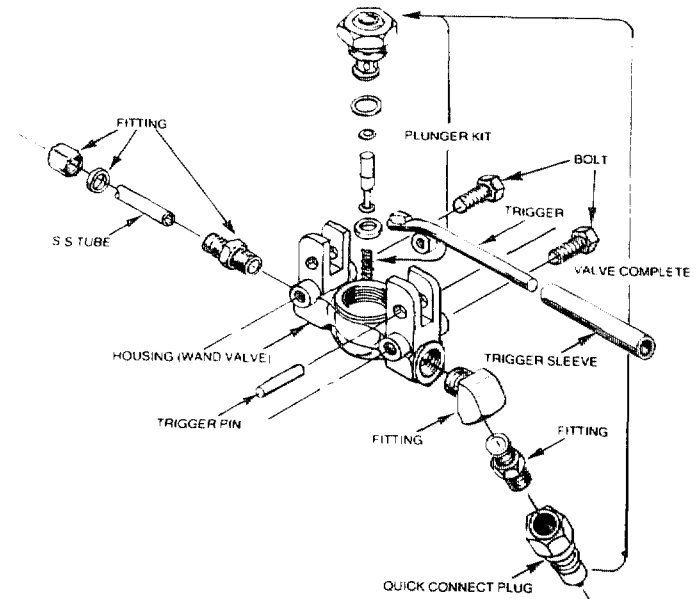
The relatively low cost of a water softener service is more than made up for in the increased life of machine parts and continued cleaning efficiency. The water softener will also increase the effectiveness of the cleaning chemical being used, therefore, less chemical will be needed.

Contact a water softener distributor in your area for information on the rental of a simple water treatment unit to carry in your truck. Be sure to change the water softener in accordance with the capability of the softener. Example: If the softener will treat 900 gallons of water and the machines uses an average of 30 gallons per hour of use, and an average of 5 hours a day, would be 150 gallons a day. 5 days would equal 750 gallons of water, therefore, the softener would be changed every 6 working days for maximum softening.

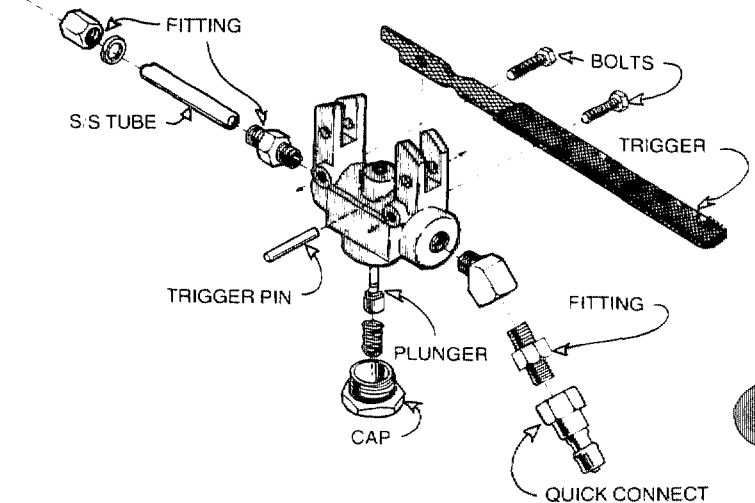
WAND ASSEMBLY



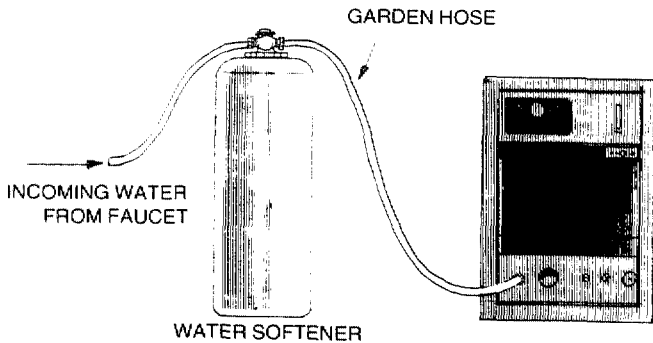
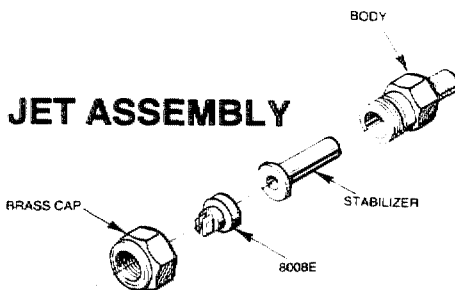
VALVE ASSEMBLY



OPTIONAL REPLACEMENT VALVE AFTER DEC. 15, 1983



JET ASSEMBLY



OPERATING INSTRUCTIONS

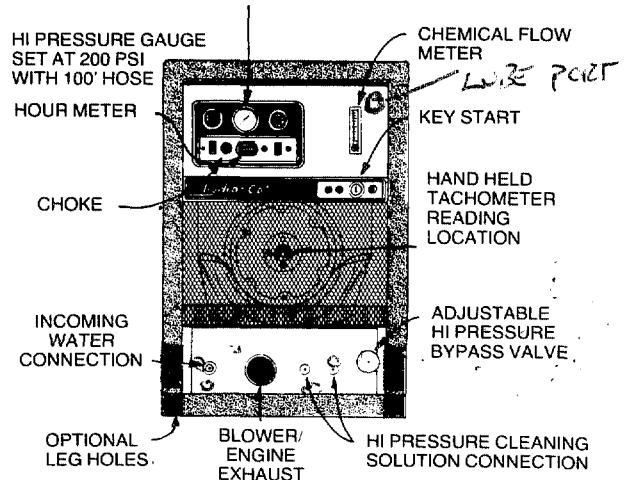
START UP

1. Perform daily/periodic maintenance as specified by the owner's manual.
2. Connect all required hoses.
3. Connect cleaning tool to length of hose required to perform cleaning.
4. **Caution:** Mix tank must be full prior to ignition.
5. Start engine (choke as required). Engine is at operating speed (recommended - 2600 RPM). Allow warm-up period of 2 - 5 minutes.
6. Spray wand to void all air from system. As the mix tank is in a fill cycle, the chemical flow meter may be adjusted to your desired setting. **NOTE:** Recommended carpet cleaning pressure is 250 - 300 PSI.
7. Once all air is voided from system, heater may be ignited. **NOTE:** If not familiar with operation of this heater, refer to heater section of the manual.
 - A. Open propane valve on the tank.
 - B. Ignite pilot on the heater.
 - C. To ignite burner, turn dial to **on** position.**NOTE:** If you suspect that the unit has been frozen - **DO NOT** light the heater. Thaw the heater and check for leaks.
8. Turn on burner, adjust dial to normal or slightly below for 200 Deg. F.
9. Commence cleaning operation
NOTE: Chemical flow meter set at 5 GPM is a 1 to 30 mix ratio and 10 GPH is 1 to 15 ratio. When flow meter is set at 10 GPH, you will be using what most chemical manufacturers recommend at 5 GPH.

SHUT DOWN

1. Turn heater to off position. Spray wand for a least 3 minutes to allow the heater coils to cool.
2. Close valve on propane tank.
3. Remove vacuum hose.
4. Flush clear water through chemical system for 10 seconds. (vinegar should be rinsed through system weekly). Turn off chemical flow meter.
5. Turn on cleaning tool to flush chemical from unit hoses and cleaning tool.
NOTE: If freeze guard is necessary, perform steps 1 & 2 of freeze guard procedure at this time.
6. At this time, the blower should be lubricated with LPS 1 or WD 40.
7. Shut engine down.
8. Drain vacuum tank. Vacuum filter should be cleaned prior to mobilization of van.
NOTE: If freeze guard is necessary, perform steps 3 - 9 of freeze guard procedure at this time.

MACHINE CONTROL PANEL



OPERATION PRECAUTIONS

MACHINE ADJUSTMENTS:

Although this unit has been factory adjusted, it may require additional adjustments to achieve optimum performance; i.e. altitude may require carb adjustment and ambient temperatures may require heat control adjustment. When required, consult an authorized representative.

ENGINE COOLING:

CAUTION Units employing air cooled engines must not be incapacitated within a van with doors and windows closed. Excessive temperatures within the engine will result in premature engine failure and a compromise of applicable warranty.

LEVEL OPERATION:

CAUTION During operation, van or trailer must be parked on level ground not to exceed + or - 10 deg.. Failure to insure proper leveling may prevent proper internal lubrication of engine, vacuum and/or high pressure components.

FREEZE PROTECTION:

CAUTION Mother nature gives little warning as to her cold spells. Therefore, protecting this equipment from freezing will save costly down-time. Placing an electric heater in the truck or parking the truck indoors, will help to insure against freezing.

LIGHTING HEATER:

WARNING Never put your face down close to the opening of the heater when lighting.

STRONG PROPANE ODOR:

WARNING Never light the heater if you smell a strong odor of propane around the heater.

HEATER:

CAUTION Never pile things around the heater, i.e. hoses, boxes, chemical jugs, etc., as this will block the flow of air required for a clean burning heater.

OPEN FLAME:

CAUTION Remember that this heater is an open flame, therefore, do not remove engine gas line while troubleshooting or store any flammable material in the truck with heater operating.

FREEZE PROTECTION

Any freezing of this machine is not covered by warranty and during the colder months of operation, careful protection should be of utmost concern.

THE FOLLOWING PRECAUTIONS ARE RECOMMENDED:

1. Run machine before leaving for the first job to insure nothing has frozen the night before, including hoses and wand.
2. Insulate the garden hose from the cold ground by running it through an extra 1 1/2 inch vacuum hose.
3. Leave truck doors closed until time cleaning begins, then open slightly for ventilation of air cooled engine.
4. On extremely cold days propane does not vaporize as quickly, therefore, venting the warm exhaust over to blow on the propane tank will stabilize the propane flow. (This is necessary if you notice a drop in heat or a low burning flame in the heater.)
5. In colder climates, insulating the truck walls and floor boards will help protect the unit.
6. Don't procrastinate during the cleaning operation or the hot water solution line will also freeze on the ground. The solution line should be insulated in extremely cold climates.
7. Whenever possible, the truck and machine should be stored in a heated garage at night or over the weekend. If not possible, place a 1500 watt electric heater inside the truck, aimed directly at the machine. Never use a propane heater - it causes excessive moisture on the truck ceiling and the possibility of it going out is higher. If the machine and truck are left outside with a heater, you should first drain all possible water from the machine cleaning tools and hoses. (They freeze also.)

TO DRAIN THE MACHINE, FOLLOW THESE STEPS:

- A. Before shutting off the machine, remove the chemical line from the chemical jug and place in a mixture of 50/50 anti-freeze and water. With the cleaning tool on, allow mixture to fill chemical system back to the chemical mix tank.
- B. Loosen the petcock valve on your bypass drain hose and allow the water to drain thoroughly from the mix tank.
- C. To remove the water from the heater and pump use the freeze guard kit which is a small air compressor that can be plugged into the dash board lighter in the truck, or air at the gas station. Using the correct connectors, first blow air into the high pressure solution male quick connect. This will force the water through the heater back through the pump and into the chemical mix tank to be drained out through the petcock valve to the ground.

Next, blow the air into the incoming water quick connect and force that water into the chemical mix tank to be drained out.

To be sure all water is out of the system, alternate between quick connectors several times.

8. BE SURE IT'S PROTECTED!

Freezing will cause GRIEF, MONEY and DOWN-TIME. Don't mess with mother nature! Remember to close the petcock valve prior to next operation of your BobCat 2/290.

CLEANING AND CHEMICAL PRECAUTIONS INFORMATION

Your mobile carpet cleaning plant has been engineered using the latest and most sophisticated technology available, to produce the finest carpet cleaning results possible. Despite this however, it remains only a tool of the carpet cleaning trade, and it can produce only as good a job as the person operating it.

There are no short cuts to good carpet cleaning, it requires time, cleaning knowledge and the use of good chemicals.

Manufacturer recommends the use of spotting agents, and traffic lane cleaners prior to the actual cleaning of carpeting, as required.

Manufacturer recommends setting heater thermostat at 'normal' setting when cleaning synthetic fiber carpets, and at 'warm' setting when cleaning natural fiber carpets.

CAUTION When cleaning cut-pile acrilan plush carpets, set heater at 'warm' setting. Using higher heater setting may result in fiber damage on this type of carpet.

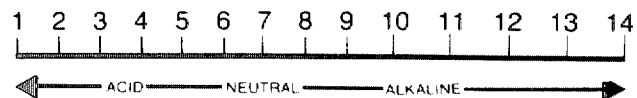
The use of some chemicals through your mobile carpet cleaning plant can seriously damage the internal plumbing, high pressure pump and heater. (Chemicals such as concentrated acids and some paint oil and grease removers w high concentration of solvents.)

Manufacturer recommends only the use of chemicals containing rust and corrosion inhibitors and water softening agents to prevent chemical build-up.

NOTE:

At no time should a chemical solution with a PH of less than 7 or higher than 10 be used in the unit.

PH CHART



CLEANING STROKE PROCEDURE/OVER-WETTING

PURPOSE:

To eliminate excess moisture remaining in the carpet fiber and the sawtooth appearance which results from diagonal movement of the cleaning tool on all types of carpet.

PROCEDURE:

Always move the cleaning tool in smooth forward and backward strokes. Apply slight pressure to the forward stroke while the solution is injected into the carpet. When extracting (drying), apply firm pressure on the forward stroke to ensure a positive "lock" for the vacuum and minimize the "hopping" effect resulting on unsmooth carpet. During the forward and reverse strokes, movement to the