AMERICAN KLEANER

OPERATION–MAINTENANCE

RAIDER SERIES

INVADER
FEARSOME–FOUR
DOMINATOR
FAST–FIVE

5951451000000

1/90

Contents

I M P O R T A N T

Please read the following prior to the installation and operation of this unit:

D A N G E R

THIS EQUIPMENT CAN BE HAZARDOUS TO THE OPERATOR'S SAFETY AND ONLY AUTHORIZED PERSONNEL WHO HAVE READ AND UNDERSTOOD THE INSTALLATION AND OPERATING MANUAL SHOULD BE PERMITTED TO OPERATE THIS UNIT. DO NOT OPERATE THIS EQUIPMENT UNATTENDED.

W A R N I N G

DO NOT use gasoline, solvent or improper rated fuels in this equipment and only fill fuel tank when unit is in an off condition, main power disconnected and all components are cool. FAILURE TO DO SO COULD RESULT IN SEVERE OR POSSIBLE FATAL INJURY TO PERSONNEL.

W A R N I N G

Install and operate this unit ONLY in areas where open flame type of equipment is permitted, such as, acetylene of electric welders, FAILURE TO DO SO COULD RESULT IN SEVERE OR POSSIBLE FATAL INJURY TO PERSONNEL.

W A R N I N G

DO NOT install or operate this unit in an enclosed room unless adequate fresh air and exhaust ventilation is available. This equipment requires intake air for proper combustion and may draw flammable vapors into combustion chamber, creating an extremely hazardous condition. FAILURE TO DO SO COULD RESULT IN SEVERE OR POSSIBLE FATAL INJURY TO PERSONNEL.

C A U T I O N

Acid forming gases such as formed in trichlorethylene vapor degreasers will attack heating coils and should be located away from the unit.

WARNING

DO NOT use any type of insecticide, toxic chemicals of heat activated chemicals that produce toxic fumes, or explosive materials in the soap solution system of this equipment. Use ONLY those detergents proven safe for human contact. FAILURE TO DO SO COULD RESULT IN SEVERE OR POSSIBLE FATAL INJURY TO PERSONNEL.

WARNING

This unit may conduct static electricity through the discharge nozzle and is not designed for cleaning applications using combustible liquids, materials or flammable gases. FAILURE TO DO SO COULD RESULT IN SEVERE OR POSSIBLE FATAL INJURY TO PERSONNEL.

SECURE discharge gun PRIOR to starting unit and secure discharge gun when not in use. Never leave discharge gun unattended with unit operating.

DO NOT operate unit with splash guard or belt guards removed (if so equipped).

WARNING

Placing gun nozzle against or in close proximity to the body during operation could cause penetration through the skin resulting in severe or possible fatal injury to personnel.

WARNING

M NOT stand or allow other personnel to stand in front of discharge gun nozzle and avoid contact with hot water discharge.

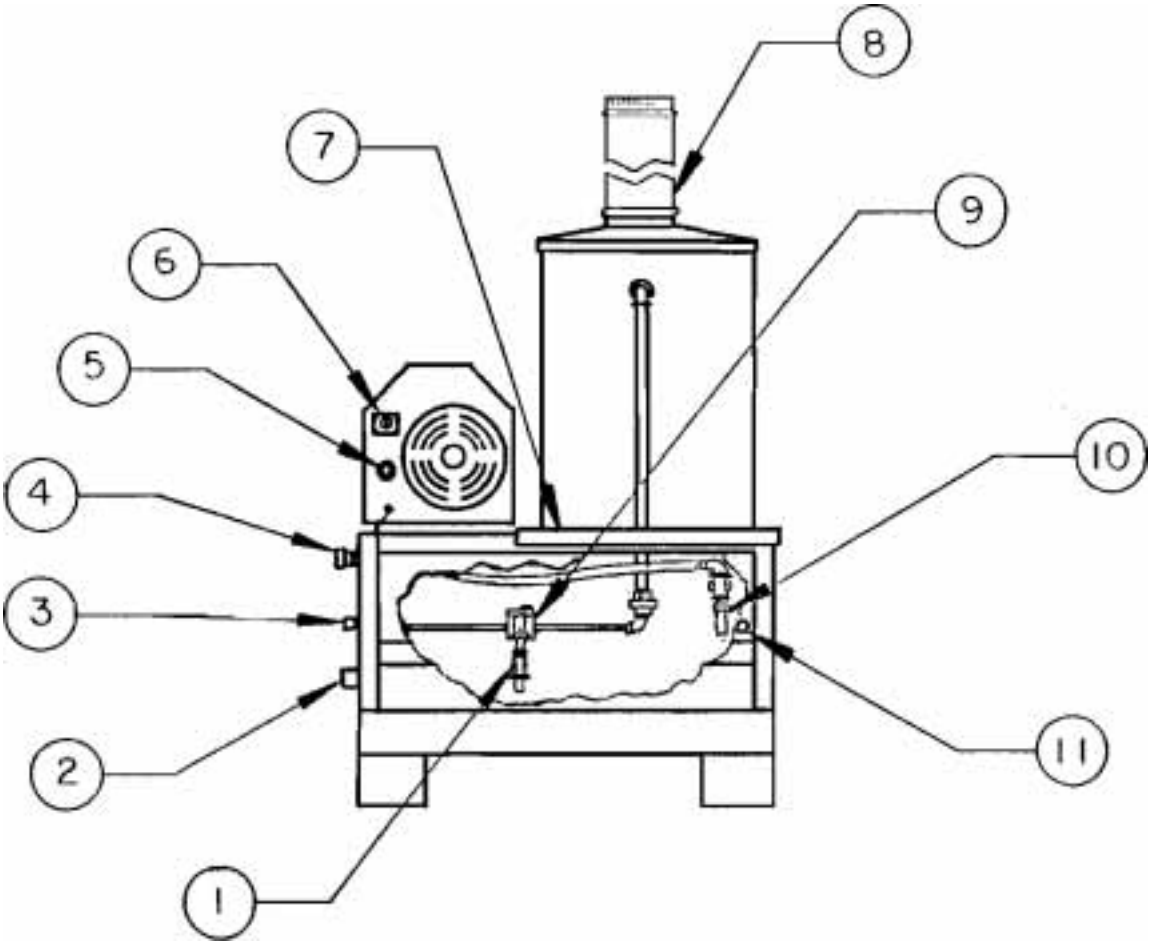
WARNING

DISCONNECT main electrical power supply prior to servicing this equipment. DO NOT manually override or disengage automatic safety controls (if so equipped).

CAUTION

When storing unit in freezing weather conditions, unit must be drained thoroughly, and it is recommended plumbing system be charged with a 50% solution of permanent type of antifreeze. Antifreeze should be used when unit is not in service for prolonged periods or being transported to extremely cold areas.

FIGURE 1
OPERATING CONTROLS



ITEM	DESCRIPTION
1	Overheat Safety Switch
2	Gas Inlet Connection
3	Pressure Hose Outlet
5	Soap Metering Valve
6	Main Pump, Burner & Stop Switch
7	Operation Warning Label
8	Vent Stack (Required)
9	Discharge Temperature control
10	Safety Relief Valve
11	Machinery Door Knob

FIGURE 2
INSTALLATION DIAGRAM

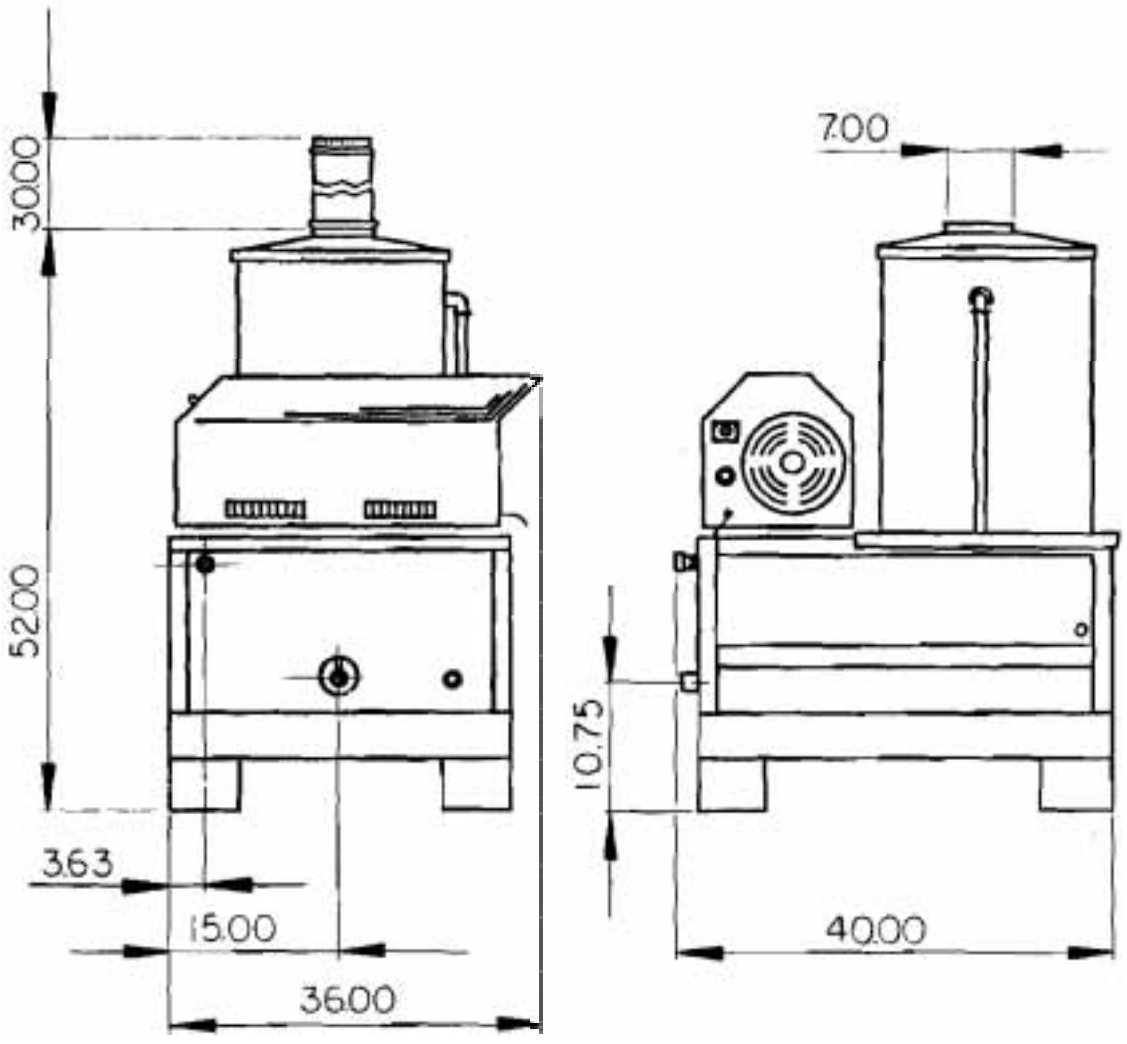


FIGURE 3
ELECTRICAL SCHEMATIC
DOMINATOR

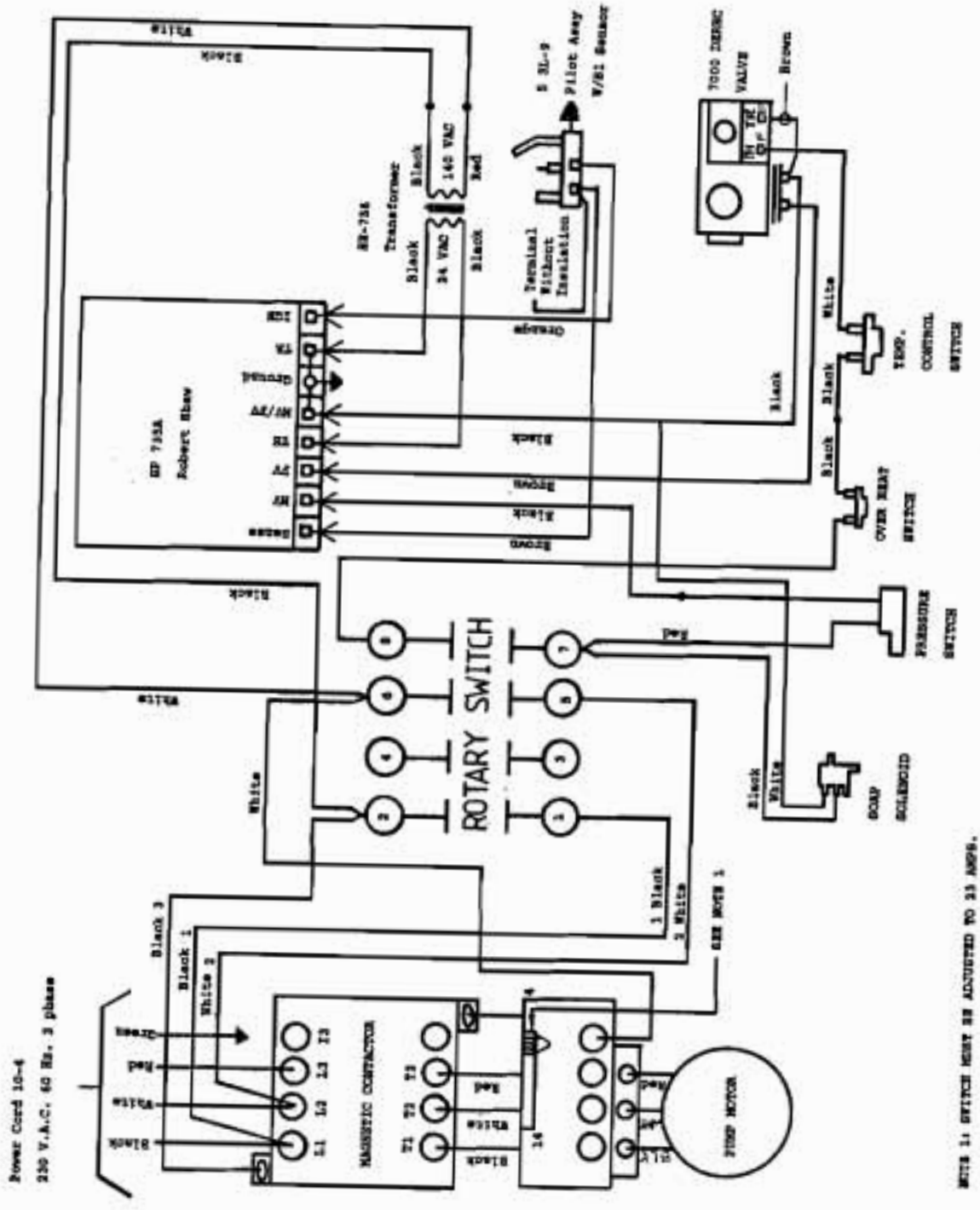


FIGURE 4
ELECTRICAL SCHEMATIC
INVADER FEARSOME FOUR FAST FIVE

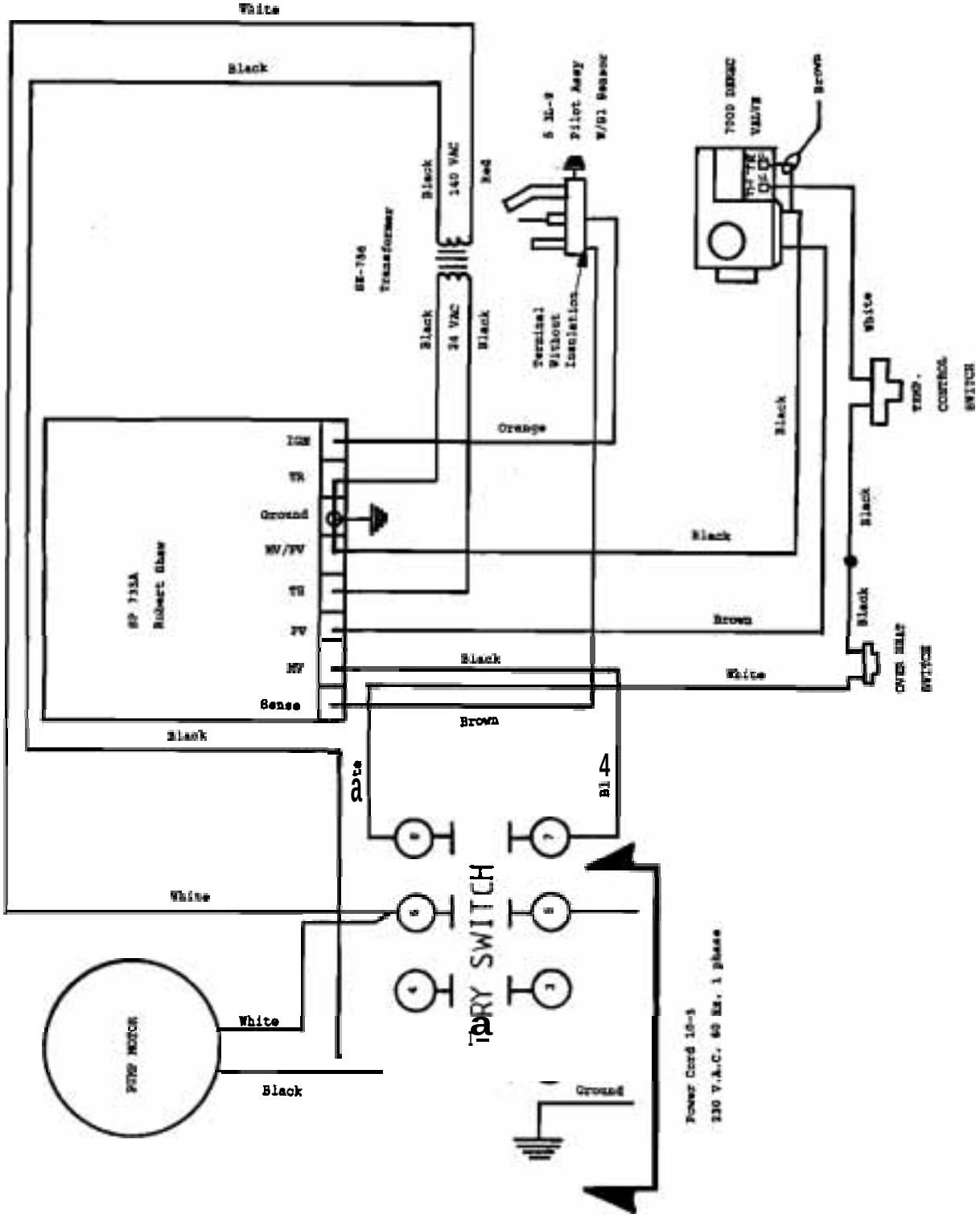
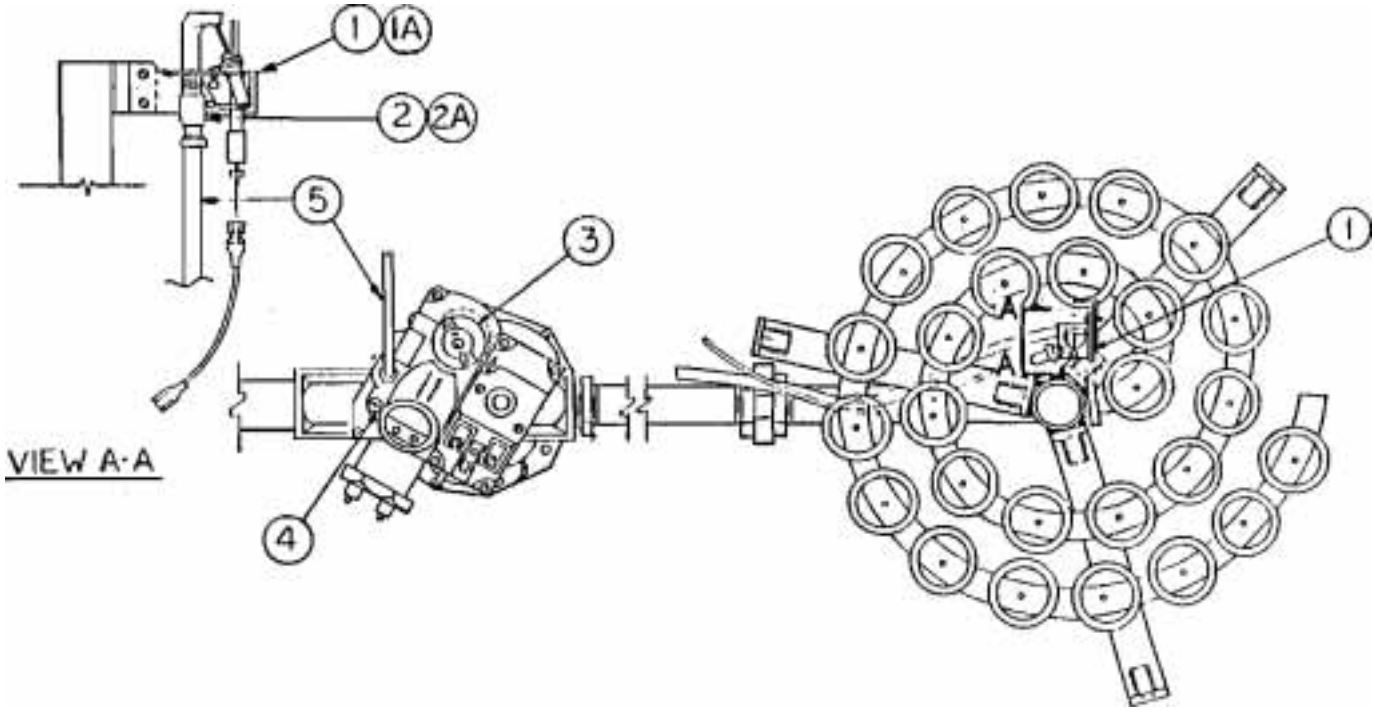
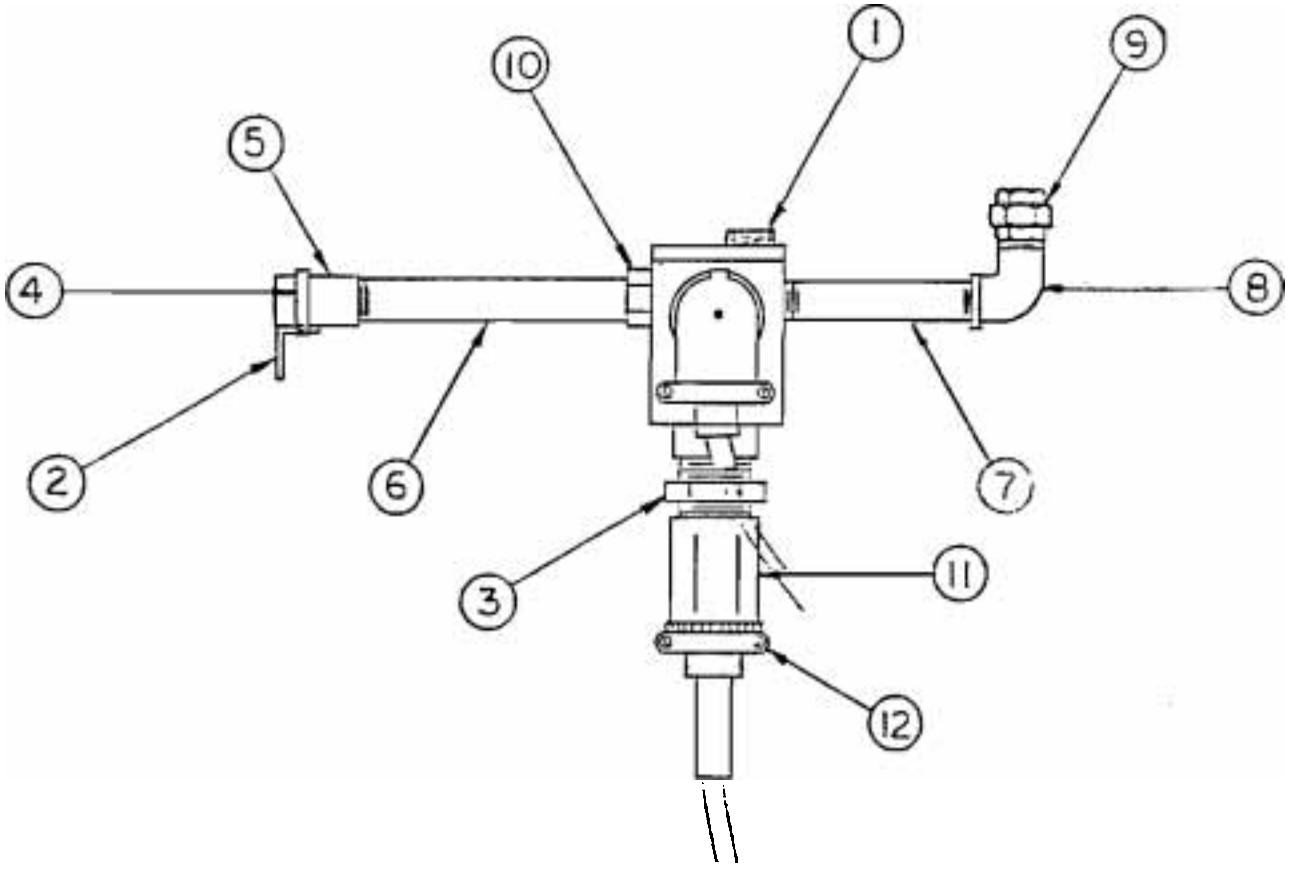


FIGURE 5
GAS VALVE CONTROLS



ITEM	DESCRIPTION
1	Pilot Assembly N.G. (.018)
1A	Pilot Assembly L.P. (.0115)
2	Orifice, N.G. (0.18)
2A	Orifice, L.P. (0.115)
3	Main Gas Control
4	Pilot Gas Regulating Control
5	Pilot Gas Line and Connection

FIGURE 6
COIL OUTLET



ITEM	DESCRIPTION
1	Adjustable Temperature Control
2	Bracket
3	Temperature Safety Switch
4	Clamp
5	Coupling, 3/8"
6	Nipple, 3/8" x 12" Long
7	Nipple, 1/2" x 12" Long
8	Elbow, 1/2" - 90° Street
9	Union, 1/2" (250 lb.)
10	Bushing (Part of Item 1)
11	PVC Coupling, 1/2"
12	Squeeze Connector

D A N G E R

This equipment can be hazardous to the operator's safety and only authorized personnel who have READ AND UNDERSTAND the installation and operating manual should be permitted to operate this unit. Do not allow this equipment to operate unattended.

1.0 GENERAL

1.1 These instructions are published by AMERICAN KLEANER MFG. Co. for the INVADER, FEARSOME FOUR, DOMINATOR and FAST FIVE series gas fired, hot high pressure washers. Paragraphs 3.0 through 9.0 provide necessary information for the operation, maintenance and trouble-shooting of the equipment, components and attachments.

2.0 DESCRIPTION AND DATA

2.1 Description:
The RAIDER series gas fired hot high pressure washers are equipped with a high pressure water pump, burner and heating coils, electric motor, together with all necessary controls and connections for use where there is available electrical, natural or L.P. gas and pressurized water source. Capacities and pressures are:

MODEL	
INVADER	4 gpm @ 2000 psi
FEARSOME FOUR	4 gpm @ 1200 psi
DOMINATOR	4 gpm @ 3000 psi
FAST FIVE	5 gpm @ 1500 psi

2.2 Tabulated Data:

A. Distributor/Manufacturer: AMERICAN KLEANER MFG. Co.
Models ..... INVADER, FEARSOME FOUR, DOMINATOR, FAST FIVE

B. Gas Requirement: All Models 440,000 BTU/HR
Size of input gas pipe is 1" diameter all models

C. Electrical Requirements:

MODEL	VOLTAGE	PHASE	AMPS	MOTOR H.P
INVADER	230 VAC	1 & 3	30	5.0
FEARSOME FOUR	230 VAC	1 & 3	30	3.5
DOMINATOR	230 VAC	3	30	7.0
FAST FIVE	230 VAC	1 & 3	30	5.0

D. Water Requirements:

MODEL	G.P.H.	PRESSURE
INVADER	300	25 to 70 psi
FEARSOME FOUR	300	25 to 70 psi
DOMINATOR	300	25 to 70 psi
FAST FIVE	330	25 to 70 psi

E. Dimensions and Weights:

MODEL	LENGTH	WIDTH	HEIGHT	WEIGHT (DRY)
INVADER	40"	36"	52"	600 lbs.
FEARSOME FOUR	40"	36"	52"	550 lbs.
DOMINATOR	40"	36"	52"	700 lbs.
FAST FIVE	40"	36"	52"	660 lbs.

3.0 PRE-OPERATING INSTRUCTIONS

3.1 Remove all packing, tape and material used to protect during shipment.

3.2 Be sure unit is installed and operated in an area free of inflammable or dangerous gases, and located in such a manner to protect structures from exhaust during operation.

W A R N I N G

Install and operate this unit ONLY in areas where open flame type of equipment is permitted. Such as, acetylene or electric welders. Failure to do so could result in severe or possible fatal injury to personnel.

W A R N I N G

DO NOT install or operate this unit in an enclosed room unless adequate fresh air and exhaust ventilation is available. This equipment requires intake air for proper combustion and may draw flammable vapors into combustion chamber creating an extremely hazardous condition. Failure to do so could result in severe or possible fatal injury to personnel.

W A R N I N G

Acid forming gases such as formed in trichlorethylene vapor degreasers will attack heating coils and should be located away from the unit.

3.3 For maximum unit performance, minimum BTU/Hour gas input is required. (See page 1.) The gas pressure to the burner must be set at approximately 5" to 6" water column pressure (manometer reading) while burner is on.

3.4 When using **L.P.** gas fuels, a tank of sufficient size to vaporize minimum BTU/Hour, under all temperature conditions, must be used to provide satisfactory performance. An L.P. Gas regulator must be installed between the LPG tank and the unit to reduce the L.P. gas tank outlet pressure to a maximum of 11" to 13" water column pressure as measured on a manometer.

3.5 Install vent stack (provided with unit) on top of heater shell hat.

NOTE: If unit is vented to the outside, a down draft diverter should be installed in the vent stack to prevent excess down draft from causing burner flame to be pushed down around burner, or causing coil damage during below freezing weather.

3.6 Install cleaning gun to one end of high pressure hose and other end of hose to cleaner's high pressure outlet connection.

3.7 Connect one end of a water supply hose to an ample water source and other end of hose to cleaner's inlet water connector. Turn hydrant valve on.

3.8 Connect cleaner's power cord to an adequately wired and GROUNDED electrical source. See paragraph ***2.2.C*** for electrical voltage for this cleaner.

W A R N I N G

DO NOT operate this equipment unless it is connected to a properly wired and GROUNDED Electrical source per local electrical codes.

3.9 Soap Mixing Instructions:
The Raider series are equipped with a syphon soap feed metered system. Liquid soap is required. Insert soap suction intake hose into soap solution supply, if required.

W A R N I N G

DO NOT use any type of insecticide, toxic chemicals or heat activated chemicals that produce toxic fumes, or explosive materials in the soap solution system of this equipment. Use ONLY those detergents proven safe for human contact. Failure to do so could result in severe or fatal injury to personnel.

3.10 Unit is now ready for operation.

S P E C I A L N O T E S

A. When unit is operated the first time, it is advisable to remove cleaning gun nozzle and flush out any loose or foreign material which may have collected in shipment or during installation. Turn pump switch "on" and allow unit to operate until clear water is flowing from the cleaning gun.

B. Close soap metering valve (Figure 1, Item 5) and allow full stream of water to flow from discharge gun, the open metering valve and meter for proper soap concentration according to job requirements.

4.0 STARTING INSTRUCTIONS

4.1 Check that water supply to unit is on and adequate for continuous unit operation.

W A R N I N G

This unit may conduct static electricity through the discharge nozzle and is not designed for cleaning applications using combustible liquids, materials or flammable gases. FAILURE TO DO SO COULD RESULT IN SEVERE OR POSSIBLE FATAL INJURY TO PERSONNEL.

SECURE discharge gun prior to starting unit and secure discharge gun when not in use. Never leave discharge gun unattended with unit operating.

4.2 Turn main switch to "pump" position (Figure 1, Item 6).

W A R N I N G

DO NOT stand or allow other personnel to stand in front of discharge gun nozzle and avoid contact with hot water discharge.

4.3 If hot high pressure wash is desired, turn main switch to burner position.

4.4 If soap solution is desired, adjust soap metering valve (Figure 1, Item 5) to meet job requirements.

4.5 When unit comes up to temperature, it is ready for full operation.

5.0 STOPPING INSTRUCTIONS

5.1 Turn main switch from "burner" to Pump" position (Figure 1, Item 6).

5.2 Continue to run water pump; until cool water flows from cleaning gun.

5.3 Turn main switch from "Pump" to "OFF" position (Figure 1, Item 6).

5.4 Turn off water supply to unit.

5.5 In extremely cold weather the cleaner must be drained thoroughly when not in use:

A. With burner off, soap metering valve closed, turn off water supply and operate pump until water supply tank is empty and air is being sucked into pump. Turn motor off.

B. Remove discharge hose from hose connection. Apply air pressure to blowdown fitting (Figure 1, Item 3), to force all water out of coil and related plumbing.

C. Open soap metering valve and drain all solution for intake hose and pump intake piping. Leave valve open so that any trapped water may expand, if frozen, with out damage to components.

NOTE: If unit cannot be stored in a protective environment or compressed air is not available, proceed to charge the pump and coils with a 50% solution of permanent-type anti-freeze solution.

6.0 MAINTENANCE INSTRUCTIONS

W A R N I N G

DISCONNECT main electrical power supply prior to servicing this equipment. DO NOT manually override or disengage automatic safety controls.

6.1 Daily Maintenance:

6.6.1 Check high pressure discharge hose and fittings for cracks, kinks, swelling, loose or leaking connections. Tighten or replace as necessary.

6.1.2 Check water pump for proper crank case oil level.

6.1.3 Check cleaning gun nozzle for wear.

6.1.4 Check soap intake suction hose and foot valve for kinks, leaks or restrictions. Repair or replace as necessary.

6.1.5 Check soap container for adequate soap supply. Recharge as necessary.

6.2 Monthly Maintenance:

6.2.1 Clean water supply tank,. Remove drain plug and flush out with clear water. Replace drain plug. Clean water pump intake screen.

6.2.2 Check oil level in water pump (sight window, rear of pump). Add oil as required.

NOTE: Change oil in water pump after first 50 hours of operation: Every 200 hours there after. Use S.A.E. 20W or 30W non-detergent oil only.

6.2.3 Inspect all valves, plumbing and fittings for leaks.

6.2.4 Inspect cleaning gun and hose for tightness, leaks or kinks. Repair or replace as required.

6.3 Occasional Maintenance:
Under most conditions, natural mineral deposits in the water will form scale on the inside of the heating coils requiring periodic removal. This descale procedure is accomplished as follows:

W A R N I N G

Read warning label on acid container prior to use. Wear rubber gloves and safety glasses when using acid solution.

6.3.1 Remove nozzle from cleaning gun and operate unit with burner "OFF".

6.3.2 Turn pump switch "OFF" and close main water valve to water supply tank.

6.3.3 Disconnect coil inlet hose (swivel connector) and attach auxiliary descale pump and tank. Auxiliary descale pumps may normally be obtained from your American Kleaner distributor.

6.3.4 Fill auxiliary descale tank approximately 1/3 full of water. Be sure water level is adequate to maintain prime of the auxiliary acid pump.

6.3.5 Insert cleaning gun (less nozzle) into auxiliary descale tank so that water is circulating from auxiliary tank thoroughly descale pump into heating coil, hose and gun, and back into auxiliary tank.

NOTE: Strain acid solution from coil through steel or copper screening to avoid recirculating scale chips.

6.3.6 Add inhibited acid scale remover to the auxiliary tank at the rate of (1) pint every (5) minutes until 2 gallons have been added. Scale remover is most effective if added slowly in this manner. Allow acid solution to circulate through machine for approximately 1 1/2 to 3 hours.

6.3.7 When cycle is complete, pump tank dry and flush entire system with clear water. Remove auxiliary equipment and reconnect coil inlet hose. Open main water valve to water supply tank.

6.3.8 With nozzle off the cleaning gun and the water supply tank maintaining a correct water level, fire the cleaner and operate for approximately five (5) minutes.

6.3.9 Cool down machine and replace gun nozzle. The unit is now ready for use.

In the event an auxiliary descale pump and tank is not available, the following steps may be taken in an EMERGENCY ONLY.

NOTE: This method is extremely hard on the water pump and may void warranty if not followed properly or if procedure is continuously repeated.

The pump manufacturer recommends to use sulfamic acid only during this procedure. Mix two (2) pounds of sulfamic acid to one gallon of water.

A. Remove nozzle from cleaning gun and operate unit with burner off.

B. Turn water supply off at float valve and pump water supply tank until it is only 1/2 full. Tie wire netting or porous cloth over end of cleaning gun (to catch scale and prevent its recirculation in the unit) and insert gun into the water supply tank. Turn pump switch "ON" so that water is being pumped from the water supply tank, through the machine, and back into the water supply tank. Be sure there is adequate water in the tank to maintain a good prime in the pump.

C. Add the acid scale remover to the water supply tank at the rate of 1/2 pint every 5 minutes until one gallon has been added. Allow acid solution to circulate through the unit for approximately 1 1/2 hours.

D. Neutralize the acid solution and dispose of in accordance with local, state and federal regulations. Remove cleaning gun from water supply tank.

E. Turn on main water valve and pump switch. Circulate clean water through the water supply tank and heating coils until clear water flows from cleaning gun.

F. With nozzle off the cleaning gun, turn burner on for five minutes. Cool down the machine and replace gun nozzle. The unit is now ready for use.

W A R N I N G

The entire descale operation is accomplished with the burner off until paragraph "F" above.

7.0 ADJUSTMENTS AS MAY BE REQUIRED

W A R N I N G

DISCONNECT main power supply prior to adjusting this equipment.

7.1 Temperature Adjustment (Figure 6, Item 1)

The temperature control has been factory adjusted to provide approximately 190° F. output temperature. Due to different input water temperature or other desired discharge temperature, it may be necessary to readjust thermostat. To change temperature, turn adjusting knob to desired temperature.

8.0 TROUBLE SHOOTING INFORMATION

As an aid in locating and correcting problems which may occur in transit or while the washer in operation, this section was developed to assist the operator. Many operational troubles are caused by inexperienced operators rather than mechanical failures. With this in mind American Kleaner has prepared this list as complete as possible to remedy problems and eliminate unnecessary maintenance in the future.

Probable Cause	Remedy
8.1 Problem: Lack of water at cleaning gun when pump is turned on.	
A) Insufficient water in water supply tank.	**A-1** Check for low water line pressure. **-2** Check float valve and float valve setting. Repair or replace. **-3** Check main water supply valve for restriction and fully "ON" position. Open valve, remove restriction.
B) Coil restricted or plugged.	B- See descale procedure, Paragraph **6.3.**
C) Solution pump not operating properly.	**C-1** Inspect check valve springs, seats. Replace if broken, pitted or scarred. **-2** Air leak in inlet plumbing. Repair or replace as necessary **-3** Worn plunger packing in pump. Replace. -4 Restriction in inlet plumbing. Locate and remove restriction.
8.2 Problem: Loss of Motor Speed.	
A) Improper voltage or frequency.	**A-1** Check motor nameplate electrical frequency. **-2** Inspect main power supply, fuses and circuit breakers for proper voltage and hertz.

8.2 Problem: Loss of Motor Speed. (Cont'd)

Probable Cause	Remedy
B) Insufficient supply wire size (gauge). Excessive length of supply wire or extension cord.	B-1 Check local Electrical code. Repair or replace.
C) Electric motor overloaded.	C-1 Check coil back pressure. Descale if back pressure exceeds 40 psi.

8.3 Problem: No spark and no pilot gas.

A) No Main power, or faulty transformer, thermostat, or limit switch.	A) Perform normal system checks of main power, main rotary switch, transformer, thermostat, limit switch, and replace faulty components.
B) Faulty ignition control unit.	B) With power on, turn thermostat to the lowest setting, wait 10 seconds and return to high setting. Set voltmeter to 24 VAC and attach probes to terminals "TR" and "TH" on the ignition control unit. If you read VAC but still no spark or pilot gas, replace ignition control.

8.4 Problem: Sparking but no pilot gas.

A) No gas supplied to pilot valve.	A) Clean pilot orifice and pilot tubing. Check pilot key adjustment at the gas control.
B) Manual valve(s) in "OFF" position.	B) Fully open all manual valves upstream of the gas control and the gas cock at gas control.

8.4 Problem: Sparking but no pilot gas. (Cont'd)

Probable Cause	Remedy
C) Faulty pilot valve or faulty wiring.	C) With thermostat turned to its highest setting, set test meter to **24** VAC scale and touch probes to "D" terminals of the gas valve. If voltage is present, but still no gas, repair or replace the valve. If no voltage, check wirings. If wiring test is OK, check ignition control.
D) Faulty ignition control unit.	D) Connect probes to "**MV/PV**" and "PV" terminals of ignition control. If reading is not **24** VAC, replace the ignition control.

8.5 Problem: Pilot gas present but no sparking.

A) Faulty ignition control unit.	A) Remove wire at "TR" terminal at the ignition control, being careful not to touch **any** metal parts; disconnect the electrode wire ("**IGN**") at the ignition control. Connect one end of jumper wire to terminal "**GND**". (**Do not** remove **existing** wire.) Attach the other end of the jumper wire to the metal shank of a screwdriver, and position the tip of the shank **approximately** 1/8" from "**IGN**" terminal. Reconnect "TR" terminal. Sparking should occur between screwdriver and the "**IGN**": terminal. If no sparking occur, replace ignition control.

8.5 **Problem:** Pilot gas present but no sparking. (Cont'd)

Probable Cause	Remedy
B) Broken or shorted electrode assembly,	B) Check electrode gap (1/32" to 1/8") or any possibility of electrode shorting to other metal parts. Be sure that all connections are tight. Also the ignition control and pilot burner must both be chassis ground. If there is still no spark, the pilot and electrode assembly must be replaced.

8.6 **Problem:** Pilot flame is lit but main burner does not come on.

A) Pilot flame, low or misaligned with sensor.	A) With thermostat on, be sure that the pilot flame impinges the top 3/4" of the sensor and the sensor is pushed all the way into the pilot bracket. Adjust pilot flame with pilot adjustment key when needed, if flame is still low check gas supply pressure and pilot line for obstruction.
B) Main burner orifices restricted.	B) Clean main burner orifices.
C) Faulty main gas operator the gas valve.	C) Set voltmeter to 24 VAC scale and in touch probes to the terminals "TH" and "TR" of the main gas operator on the gas valve. If voltage is 24 VAC and still the burner won't turn on, replace main gas operator.

8.6 Problem: Pilot flame is lit but main burner does not come on. (Cont'd)

Probable Cause	Remedy
D) Faulty flame sensor or flame sensor wire.	D) When performing the following test BE SURE POWER IS "OFF". Using a continuity checker or with the test meter set to "OHM" scale, check continuity by having one probe touching the flame sensor tip and the other probe to "Sense" terminal of the ignition control. OHM meter should read "0" confirming that continuity is present. If not, remove wiring from sensor and test individually. Replace component(s) which shows no sign of continuity.
E) Faulty wiring or ignition control unit.	E) As in test C, if no 24 VAC is read after pilot has been burning for several minutes, connect probes to "MV/PV" and "MV" terminals in the ignition control. If 24 VAC is present, repair or replace wiring. If not, replace ignition control.

8.7 Problem: Pilot cycles on and off by itself.

A) Faulty "D" valve.	A) With thermostat at highest setting, test "D" valve terminals for voltage. If you read 24 VAC, replace "D" valve.
B) Faulty wiring or ignition control.	B) As in test A, if you don't read 24 VAC connect the probes to "MV/PV" and "PV" terminals at the ignition control. If 24 VAC is present, repair or replace the wiring. If no 24 VAC is read, replace the ignition control.

8.8 Problem: Main burner shuts down before desired temperature is reached.

Probable Cause	Remedy
A) Pilot flame, low or misaligned with sensor	A) Perform Item A of section 8.6
B) Improperly set or faulty thermostat	B) Check if thermostat circuit remains closed until reaching the desired temperature. If not, adjust the knob counter clockwise bit by bit until such time that the circuit opens ONLY when the desired temperature is reached. If this adjustment does not work, replace thermostat.

9.0 GAS REQUIREMENTS

9.1 Gas Connection:
For maximum performance, the unit requires minimum BTU/HR. The gas pressure at the burner must be set at approximately 5" to 6" water column pressure (manometer test) while the burner is on.

All Models 440,000 BTU/HR
Size of input gas pipe. . . . . 1" dia. all models

9.2 Natural Gas:
Based on 1050 BTU per cubic foot. the following pipe sizes should be used when running a gas line form a meter with an outlet pressure of approximately 7" water column. Gas inlet on unit is 3/4 " I.P.S. and the main feed line must be reduced at the unit only.

Distance from Meter:	Pipe size
0 feet to 50 feet	1 1/4 " IPS
0 feet to 150 feet	1 1/2 " IPS
0 feet to 300 feet	2 " IPS

9.3 LPG Fuels:
2500 to 3200 BTU/HR. A tank of sufficient size to vaporize minimum BTU/HR, under all temperature conditions, must be used to guarantee full performance of the cleaner. A requlator must be used to guarantee full performance of the-cleaner. A regulator must be incorporated between the tank and high pressure cleaner to drop the tank outlet pressure to a maximum of 11" to 13" water column pressure. The following pipe sizes should be used when running a pipe from regulator to cleaner.

Distance from meter	Pipe Size
0 feet to 50 feet	3/4 " IPS
0 feet to 200 feet	1" IPS
0 feet to 300 feet	1 1/4 " IPS

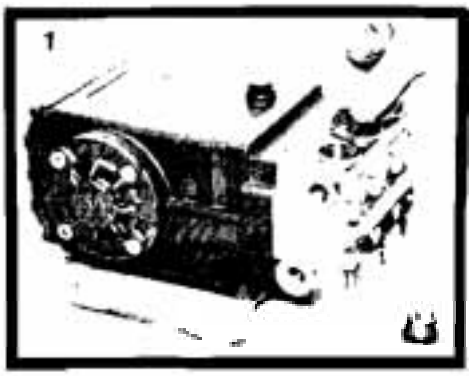
NOTE: A gas shut off cock should be installed adjacent to the machine where it will be easily accessible for use when servicing the cleaner.

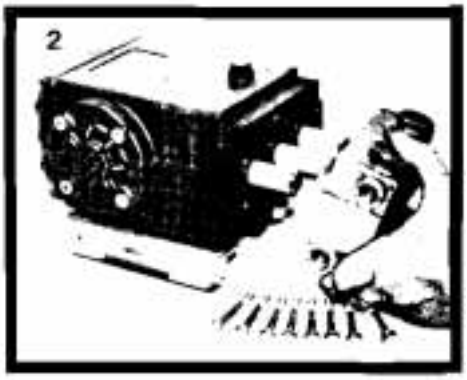
NOTE: Whenever possible install a "drip leg" in the gas piping at the cleaner gas inlet.

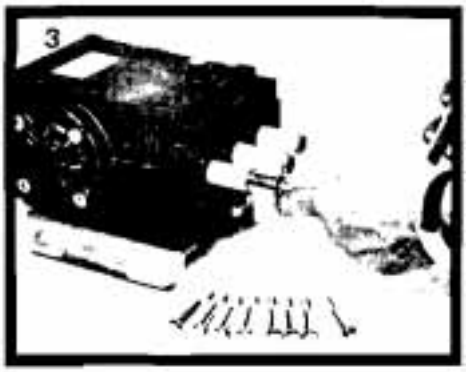
WATER PUMP TROUBLE SHOOTING

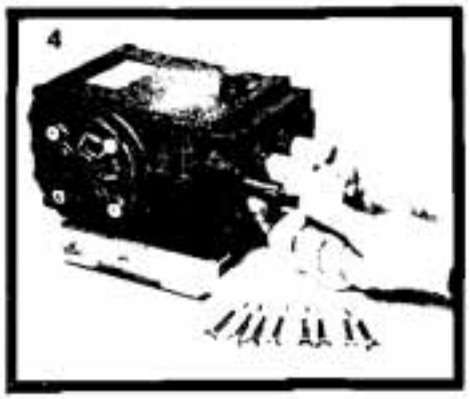
PROBLEM	CAUSE	REMEDY
Pulsation	Faulty pulsation damper.	Check precharge; if low, recharge it or install a new one.
Low Pressure	Worn nozzle.	Replace nozzle, of proper size.
	Belt slippage.	Tighten or replace; use correct belt.
	Air leak in inlet plumbing.	Disassemble, reseal and reassemble.
	Relief valve stuck. partially plugged or improperly adjusted valve seat worn.	Clean, adjust relief valve; check for worn and dirty valve seats. Kit available.
	Inlet suction strainer clogged or improperly sized.	Clean. Use adequate size. Check more frequently.
	Worn packing. Abrasives in pumped fluid or severe cavitation. Inadequate water.	Install proper filter. Suction at inlet manifold must be limited to lifting less than 20 feet of water or -8.5 PSI vacume.
	Fouled or dirty inlet or discharge valves.	Clean inlet and discharge valve assemblies.
	Worn inlet, discharge valve blocked or dirty.	Replace worn valves, valve seats and/or discharge hose.
	Leaky discharge hose.	
Pump runs extremely rough. pressure verv low	Restr cted inlet or air entering the inlet plumbing	Proper size inlet plumbing; check for air tight seal
	In et restrictions and or air eaks Stuck inlet or discharge valve	Replace worn cup or cups, clean out foreign material replace worn valves
Water leakage from under. manifold. 'Slight Leakage	Worn packing	Install new packing.
Oil leak between crankcase and pumping section.	Worn crankcase piston rod seals O-rings on plunger retainer worn.	Replace crankcase piston rod seals. Replace O-rings.
Oil leaking in the area of crankshaft.	Worn crankshaft seal or improperly installed oil seal-O-ring.	Remove oil seal retainer and replace damaged O-ring andior seals.
	Bad bearing.	Replace bearing.
Excessive play in the end of the crankshaft pulley.	Worn main bearing from excessive tension on drive belt.	Replace crankcase bearing and/or tension drive belt.
Water in crankcase.	May be caused by humid air condensing into water inside the crankcase.	Change oil intervals. Use any high grade automotive 30 weight nondetergent oil.
	Worn packing and/or piston rod sleve, O-rings on plunger retainer worn.	Replace packing. Replace O-rings.
Oil leaking from underside of crankcase.	Worn crankcase piston rod seals.	Replace seals
Oil leaking at the rear portion of the crankcase.	Damagedcrankcase, rear cover O-ring, drain plug O-ring: or sight glass O-ring.	Replace cover O-ring, drain plug O-ring, or sight glass O-ring.
Loud knocking noise in pump.	Pulley loose on crankshaft	Check key and tighten set screw
	Broken or worn bearing.	Replace bearing
Frequent or premature failure of the packing.	Scored. damaged or worn plunger.	Replace plungers.
	Overpressure to inlet manifold.	Reduce inlet pressure.
	Abrasive material in the fluid being pumped.	Install proper filtration on pump inlet plumbing.
	Excessive pressure and/or temperature of fluid being pumped.	Check pressures and fluid inlet temperature; be sure they are with in specified range.
	Over pressure of pumps.	Reduce pressure.
	Running pump dry.	Do not run pump without water.

PROCEDURE FOR SERVICING WATER PUMPS









The Valve Assemblies

Photo **1**

1) All inlet and discharge valves can be serviced without disrupting the inlet or discharge plumbing. The inlet and discharge valves are the identical in all models.

2) To service any valve, remove valve cap and extract valve assembly.

3) Examine o-rings and replace if there is any evidence of cuts, abrasions, or distortion.

4) Remove valve assembly (retainer, spring, valve, valve seat) from valve cavity.

5) Remove o-ring from valve cavity.

6) Only one valve kit is necessary to repair all the valves in the pump. The kit includes new o-rings, valve seat, poppet, spring and retainer, all pre-assembled.

7) Install new o-ring in valve cavity.

8) Insert assembly into valve cavity.

9) Replace valve cap and torque to specifications.

Removing Manifold Head

Photo **2**

1) Remove the fasteners retaining head.

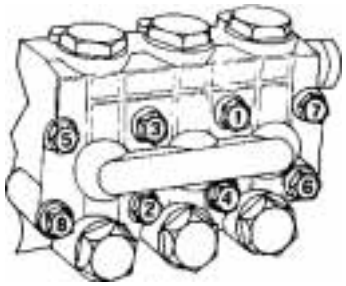
2) Separate head from crankcase. NOTE: It may be necessary to tap head lightly with rawhide mallet to loosen. CAUTION: When sliding head from crankcase use caution not to damage plungers.

3) The V-packing assemblies may come off with the head. At this point, examine plungers. Plunger surfaces should be smooth and free from scoring or pitting; if not, replace.

4) Reinstall manifold head and torque to specifications per sequence described below.

TORQUE SEQUENCE FOR TIGHTENING HEAD

Install all head bolts fingertight. Torque to 10 foot pounds in sequence as shown, then retorque to specifications, again, in sequence shown.



PROCEDURE FOR SERVICING WATER PUMPS (CONT'D)

Replacing Plungers

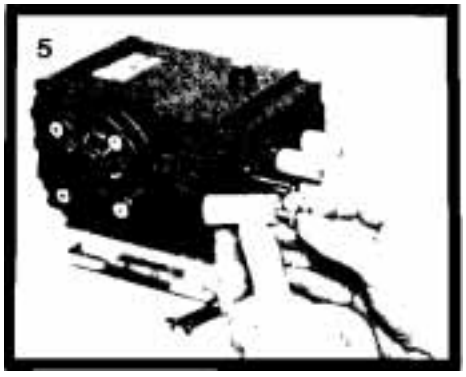


Photo 3, 4 and **5**

1) Remove stainless steel piston screw and plunger from piston rod.
2) If slinger washer comes off with plunger, be certain this is replaced before new plunger is installed.
3) Separate piston screw from plunger.
4) Install new o-ring and teflon backup-ring on piston screw.

   NOTE: A film of grease on the outside of the o-rings insures a better installation.

5) Carefully press piston screw into plunger.
6) Slide new plunger over the piston guide and torque to specifications.

Replacing V-Packings

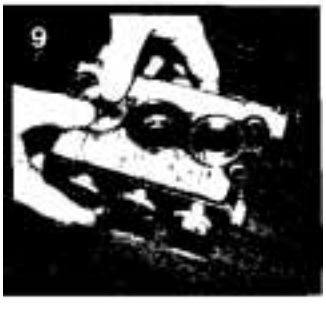
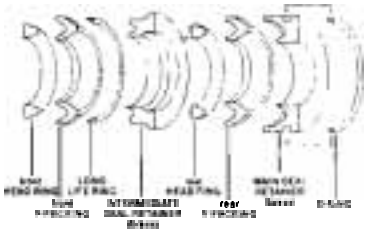


Photo 6, 7, 8 and **9**

1) Remove manifold from crankcase.
2) Insert proper extractor collet through main seal retainer. Tighten collet and extract retainers, v-packings and head rings.
3) Place proper insertion tool in cylinder and install front head ring, v-packing and long life ring and press firmly into cylinder until they will go no further using proper insertion tool.
4) insert intermediate seal retainer, pressing it firmly into cylinder until it will go no further using proper insertion tool. Install rear head ring, v-packing and main seal retainer into cylinder in order shown and press firmly into cylinder.
5) Repeat this sequence for each cylinder.
6) Coat each plunger with grease and carefully remount manifold. Torque head to specifications.

TYPICAL GENERAL PUMP PACKING CROSS SECTION



WATER TREATMENT FOR STEAM AND HOT PRESSURE CLEANERS

Water treatment is the responsibility of the user. The treatment of water, care of cleaner and accessories, are beyond the control of the manufacturer. Provisions for water treatment, when required, should be planned and installed prior to placing cleaner in service.

THE **MANUFACTURER,** ITS DISTRIBUTORS, AGENTS, AND DEALERS CANNOT BE HELD RESPONSIBLE FOR MALFUNCTION OR DAMAGES DUE TO INADEQUATE **WATER** TREATMENT.

In general, all water used in a modern cleaner must:

a. Have controlled or zero hardness.
b. Have controlled or zero free oxygen.
c. Have sufficient alkalinity (pH).

Normal Hardness:
In normal cleaning operations and when water hardness is not excessive (under 15 grains), the use of quality cleaning compounds and liquid concentrates, when used in recommended amounts, will properly treat water for the conditions outlined above. However, even under the most ideal conditions, hard water will, over a period of time, deposit some scale within the cleaner's coils.

The build-up of scale **(mineral deposit)** is relative to type of hardness, quality of compounds or concentrates used, and hours per week of operation. Removal of this scales quite simple through the use of a quality inhibited acid. The frequency of descaling should not exceed two to three times per year. Excessive descaling is indicative of poor quality soaps, inadequate usage, or excessive water hardness.

Excessive Hardness:
If the water hardness is excessive and cannot be controlled by use of quality compounds, and IN ALL CASES WHERE SUCH COMPOUNDS CANNOT BE USED as in aluminum brightening, and/or phosphatizing, a means of removing mineral hardness from the water must be used prior to supplying the water to the cleaner.

Free Oxygen and Other Gases:
While ion exchange type water softening will eliminate coil scale formation, and filter out much of the sludge (suspended solids), it will neither remove nor control excessive oxygen or other gases.... the cause of interior corrosion of heating coils and plumbing. Any good water treatment compound, used in the recommended quantity, will provide free oxygen control and proper pH adjustment during operation and can be metered into the soft water being supplied to the cleaner through the cleaner's regular soap system, instead of soap. The use of such chemical treatment will require a

normal increase of only 1/4 of 1% of the acids or solvents being used to overcome the slight increase in the water alkalinity.

Sizing of Water Softeners:

1. Determine feedwater hardness in grains per gallon (1 grain per gallon equals 17.11 parts per million).

   Example: 342 p.p.m. equals 20 g.p.g..

2. Determine gallonage between the required regeneration periods (grains per gallon times gallons per hour capacity of cleaner, times hours of daily or weekly use, times 1.15-15% safety factor) equals size required.

   Example: 300 G.P.H. Hot Washer: 342 parts per million hardness used 4 hours per day - 6 days per week (342 p.p.m. divided by 17.1 = 20 grains per gallon). Objective: Size of softener for manual, weekly or daily automatic time clock type.

A. Manual - Weekly:

300	aallons per hour
x 4	hours per day
1,200	gallons per day
x 6	days per week
7,200	gallons per week
x 20	grains per gallon
144,000	grains per week
x 1.15	Safety Factor
165,600	grains per week

B. Automatic Daily:

300	aallons per hour
x 4	hours per day
1,200	gallons per day
x 20	grains per gallon
24,000	grains per day
x 1.15	Safety Factor
27,600	grains per day

   A. Requires a 166,000 grain Manual Softener to be regenerated once each week.

   B. Requires a 28,000 grain Automatic Softener to be regenerated daily.

NOTE: The above is a guide to assure selection of proper size and type of water softening equipment. In all cases we would recommend consulting your local water softener dealer. Hardness of your water supply can be obtained by contacting local water department, city engineer, or your local water softener dealer.