

# ThorWorks Industries, Inc.

Item Purchased: \_\_\_\_\_ Model No.: \_\_\_\_\_  
Serial No.: \_\_\_\_\_ Acceptance/Ship Date: \_\_\_\_\_  
Company: \_\_\_\_\_ Contact: \_\_\_\_\_  
Address: \_\_\_\_\_ City: \_\_\_\_\_  
Zip/Postal Code: \_\_\_\_\_ State: \_\_\_\_\_ Country: \_\_\_\_\_

## CORRESPONDENCE

All correspondence regarding this equipment or general correspondence should be addressed to:

**ThorWorks Industries, Inc.**  
**PO Box 2277**  
**Sandusky, OH 44870**

In referring to the equipment, kindly state the Model Number, Serial Number and any Part Number involved.

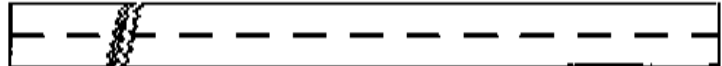
INDUSTRIES  
**THORWORKS**

CALIFORNIA

Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

# Crack Pro.

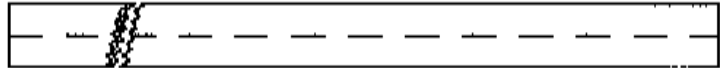


ThorWorks Industries, Inc.  
Sandusky, Ohio  
(419) 626-4375

## WARNING !!

WHEN THE BURNER IS ON DO NOT  
EXCEED 10 MPH WHILE TOWING, OR  
DAMAGE TO THE BURNER OR MACHINE  
MAY OCCUR.

# Crack Pro<sup>®</sup>



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## TABLE OF CONTENTS

	PAGE
WARRANTY	1
SAFETY	2-6
PRE-OPERATION INSPECTION	7-8
OPERATING INSTRUCTIONS	9-13
FLUID SPECIFICATION	14-15
TROUBLE SHOOTING	16-18
MAINTENANCE SCHEDULE	19
PARTS LISTS & SCHEMATICS	20-32
DIESEL BURNER INSTRUCTIONS-PARTS LIST	33-49
DIESEL ENGINE MANUAL	50-85
MSDS FOR HYDRAULIC & HEAT TRANSFER OIL	86-93



## ThorWorks Industries Inc. Limited Warranty for Equipment

ThorWorks warrants that its products are of quality material and workmanship. ThorWorks agrees to replace, within a one (1) year period from date of delivery, or at its option, repair without charge, any part of their manufacture which proved defective. The repair or replacement will be free of charge F.O.B. Sandusky Ohio, providing the damaged part or parts are returned freight prepaid to ThorWorks and investigation show such repair or replacement is made necessary by inherent defect of material or workmanship. Obvious damage by misuse or abuse voids any liability on ThorWorks part. Should you request the replacement part or parts be sent via 'next day air', you will be charged the difference between ground service and 'next day air'.

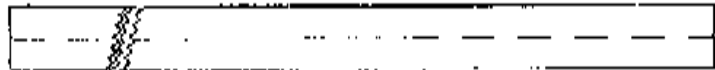
It is hereby understood that engines, motors, pumps, or other components purchased by ThorWorks for use on its equipment are not warranted by ThorWorks and are sold only with the standard warranty of the manufacturer of that component. ThorWorks will send the returned component back to the respective manufacturer for evaluation. Should the manufacturer deny the warranty claim, then ThorWorks will not honor any warranty and you will be required to pay ThorWorks for the replacement item that was shipped to you.

Any claims for defective material or workmanship must be made prior to the expiration of thirty (30) days from the date the failure occurs, and in all cases prior to the expiration of the warranty period of one (1) year. It is the intent of this paragraph to limit ThorWorks liability solely to the cost of replacement parts, F.O.B. factory, or at the option of ThorWorks, to repair of the defective part or parts. No allowances for damages, lost revenues or lost time will be recognized.

This warranty is null and void if other than genuine ThorWorks parts are used. ThorWorks is constantly striving to improve their products. Changes in design and improvement will be made whenever the manufacturer believes the efficiency of the product will be improved, without incurring any obligation to incorporate such improvements in any machines which have been shipped or are in service.

In an effort to continue to improve product quality, ThorWorks reserves the right to change specifications without notice. Any modification or alteration of this machine without prior approval of the manufacturer may void the warranty.

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## INTRODUCTION

Congratulations on the purchase of your new Crack Pro joint sealing machine. This machine is manufactured with the commitment of quality that Crack Pro is known for. It is manufactured for high speed melting of joint sealing material and the shortest melting time for all hot pour materials.

This manual will assist you in the maintenance and operation of your joint sealing machine for many years.

## SAFETY WARNINGS

**The high operating temperatures of your joint sealing machine and materials require special training and maintenance of your equipment. Please read and follow these operating instructions to every detail.**

# FIRST AID FOR MOLTEN ASPHALT CEMENT BURNS

## In the event of a MOLTEN ASPHALT CEMENT BURN:

COOL the asphalt cement and affected parts of the body immediately.

Methods of cooling (in order of preference):

1. Completely submerge affected area in ice water;
2. Completely submerge affected area in tap water;
3. Place affected area under running water.

## DO NOT DELAY

Use any available water, cooler than body temperature, while arranging for better cooling.

**CAUTION: DO NOT** apply ice directly to affected area.

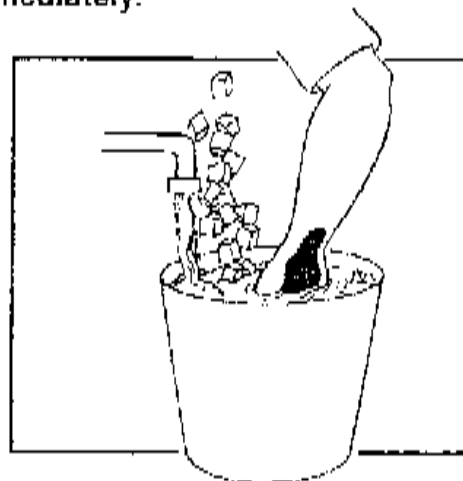
LEAVE cooled asphalt cement on affected area.

Proceed with the following:

**MINOR ASPHALT CEMENT BURNS**—at first opportunity get victim to physician.

Includes:

Injury to small areas of fairly insensitive flesh involving a small quantity of asphalt cement.



**SERIOUS ASPHALT CEMENT BURNS**—as soon as possible get victim to:

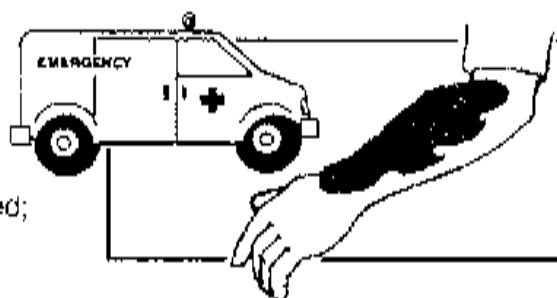
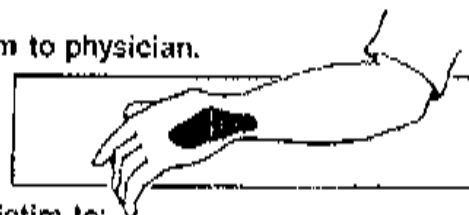
Hospital \_\_\_\_\_

Clinic \_\_\_\_\_

Physician's Office \_\_\_\_\_

Includes:

Injury to the head, face or extremities;  
Injury when large amounts of asphalt cement are involved;  
Evidence of nausea or faintness.



## TREATMENT FOR SHOCK

In the event shock occurs, do the following:

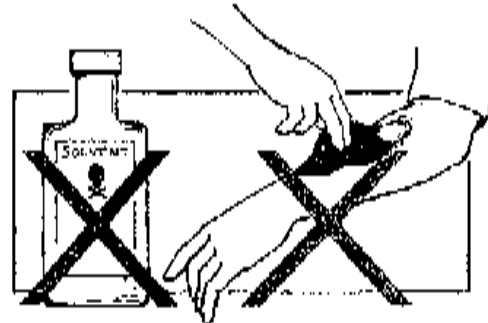
1. Keep victim lying down and quiet.
2. Keep victim covered with a blanket or something similar to keep body temperature at normal, 98°F (37°C).
3. Keep victim's head lower than feet to promote blood supply to head and chest.

**DO NOT ATTEMPT TO REMOVE THE ASPHALT CEMENT**

with products containing solvents or ammonia.

Natural separation will occur in about 48-72 hours.

If necessary, for early removal, soak bandage in mineral oil and place over affected area for 2 to 3 hours.



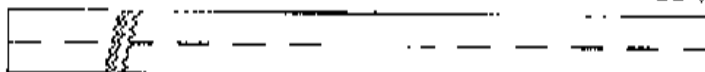
A Safety Information Service of the .

**NAPA**

**NATIONAL ASPHALT PAVEMENT ASSOCIATION**

6811 Kenilworth Avenue ■ Riverdale, Maryland 20737-1333 ■ (301) 779-4880 ■ FAX (301) 779-8817

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## CHECK IT OUT

Know what protective devices your machine is equipped with and see that each item is securely in place and in operating condition.

For example:

- 1.warning decals
- 2.guards
- 3.material hose clamps and protective sleeve
4. grounding wires

## KNOW YOUR MACHINE

Have all of the repairs been made that you reported?The most minor malfunction could be the result of more serious trouble.

## FIRE PREVENTION

Avoid fire hazards such as:

- 1.Always stop the engine when refueling,do not refuel while smoking or when near an open flame or sparks.
- 2.Always wipe up any spills immediately.
- 3.Batteries produce explosive gases,keep open flame or sparks away.
- 4 Remove all trash or debris from the machine,make sure that oily rags or other flammable materials are not stored in or on the machine.
- 5.Check for fuel,engine oil,and hydraulic leaks,replace worn or damaged hoses.
- 6.Inspect electrical wiring for worn or damaged insulation,replace as needed.

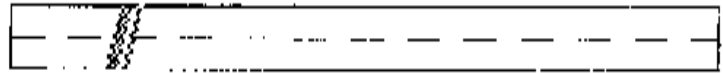
## WARNING:LETHAL FUMES !

Engine and burner exhaust gases contain carbon monoxide,Carbon monoxide is odorless,colorless and can cause death if inhaled.Avoid inhaling exhaust fumes,and never run the burner or engine in an enclosed building or confined area Symptoms of poisoning are:

- 1.dizziness
- 2.headache
- 3.weakness and sleepiness
- 4.vomiting



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**SAFETY IS YOUR RESPONSIBILITY !**

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**ONLY YOU CAN PREVENT INJURY !**

## **DRESS FOR SAFETY**

When operating your Crack Pro equipment always wear the following:

1. long pants
2. long sleeved shirt
3. heat resistant gloves
4. eye protection ( face shield is preferred )
5. work shoes
6. safety vest

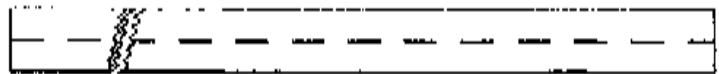
## **WARNING: MOVING PARTS**

Keep hands, feet, hair, and clothing away from all moving parts. Never operate the machine with covers, shrouds, or guards removed. Do not wear loose or dangling clothing or jewelry near the equipment. It could be come caught and possibly cause serious injury or death.

## **LEARN TO BE SAFE**

1. STUDY THE OPERATORS MANUAL and other pertinent information furnished with the equipment. Learn your machines operating and maintenance characteristics, capacities and limitations.
2. Learn the location and function of all controls, indicators, and warning devices
3. Be familiar with the safety devices on your machine.
4. Learn to recognize the machines warning and safety signals, they will alert you to conditions that may make it hazardous to continue operating.
5. Carefully read and follow all safety signs and instructions on the machine.
6. Keep safety signs and instructions in good condition, replace missing or damaged signs immediately.

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5. Do not open the tank lid and put your head directly over the opening. Besides not being good to breathe, there may be enough oxygen introduced into the tank to cause the sealant to self ignite.

## WALK AROUND INSPECTION

Before each day, walk around the machine and inspect for leaks, loose or missing parts, damaged parts, or parts out of adjustment. Perform all recommended daily maintenance.

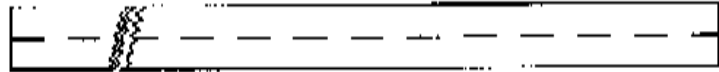
## TRAFFIC CONTROL

Proper traffic control is your responsibility. Never place sealant in an uncontrolled area. Protect vehicles and pedestrians from the work place until the sealant has thoroughly cooled ( 100°F or the pavement surface temperature )

## REMEMBER:

**ONLY YOU CAN PREVENT INJURY TO  
YOURSELF AND OTHERS !**

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## IMPORTANT

Even though your Crack Pro joint sealing machine is ready for operation when you receive it, certain items should be checked before putting it to use. Nuts, set screws, and bolts should be checked to assure that no loosening occurred during shipment. Most important items to check are listed below.

### THE ENTIRE UNIT SHOULD BE CHECKED

If you have any questions on the operation of this machine discontinue operation of the machine and call the factory immediately. ( 419-626-4375 )

Check to be sure the HTO vent pipe is clear and open for venting  
( Located on the HTO expansion tank )

Check wheel lug nuts after first 100 miles of travel

## IMPORTANT

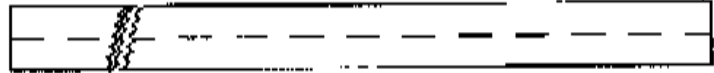
Never operate machine unattended.

Never exceed heat transfer oil limit of 500°F when operating.

Should the protective sleeve on the heated hose become damaged in any way, do not use. Replace the hose immediately.

**NEVER** move the hose when it is not heated. Doing so can kink the inner tube resulting in a damaged hose not covered by warranty.

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Do not expose material hose to direct flame.

Close tank lid before transporting.

Caution should be used when loading blocks to prevent possible splash of hot material. Set material block ( one at a time ) on lid. Close lid allowing block to drop into material tank.

Do not breathe joint sealing material fumes.

Do not load more than four boxes of material into machine at one time.

Do not exceed 55 mph when towing.

Do not operate machine in the rain.

Do not pressure wash the burner area at front of machine.

Do not work on machine while it is in operation

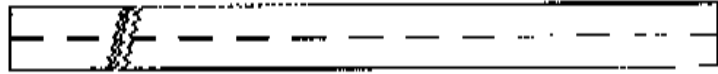
Do not work on machine when heat transfer oil has been heated over 90°F.

Never expose material tank to an open flame.

Proper clothing should be worn at all times.

\*long sleeve shirt \*face shield \*high temperature gloves \*long pants

# Crack Pro



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## IMPORTANT

The heated hose on this machine operates on 120 volts ac. Every caution has been taken to ensure a safe operating machine.

The information listed here needs to be told to anybody who uses or works on this machine.

Never operate when conditions are wet. Allow the machine to dry completely before using.

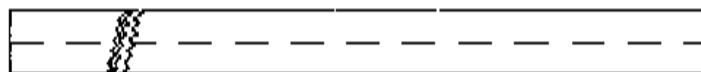
The digital temperature control box houses both 120 volts ac and 12 volts dc. While they are separated, anybody doing diagnostic testing needs to be made aware of the dual voltages.

### **DO NOT MOVE THE HOSE WHEN IT IS COLD!**

Doing so may kink the inner tube resulting in a hose that will be destroyed, and will have to be replaced. It will not be covered by the machine's standard warranty.

Should the protective sleeve become cut or damaged in any way, do not use. Electrical wires are wound around the inner hose, any exposed wires are an electrocution hazard. Replace the hose immediately.

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## OPERATOR INSTRUCTIONS

The heated hose is an electrical device. **Extreme care must be taken in how it is used and treated. It must be inspected daily for damage to the outer cover.**

Completely read and understand all owners manuals before trying to operate this machine.

Check engine, hydraulic, and heat transfer oil levels before starting. The heat transfer oil level must always be checked when it is **COLD**. Never attempt to check it when the oil is hot, or severe injury could occur.

Load the machine with material and fuel. For first time use or an empty tank, lay as many blocks as possible on the tank floor. Put the blocks in with the widest part touching the floor. This promotes faster melt times.

Start the engine and turn on the burner on-off switch located on the front of the digital temperature controller. The digital controllers monitor the heat transfer oil temperature, and the material temperature, along with the heated hose. Turn on the voltmeter switch. **See the next page for control settings and operation.**

The controller will cycle the burner off and on as the temperature of the heat transfer oil increases and decreases. The heat from the transfer oil will be absorbed by the material in the tank.

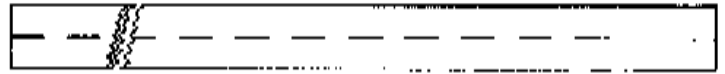
On the top rear curb side corner are two thermometers. One is for the heat transfer oil and the other is for the material tank. Both thermometers will correspond with the digital readouts on the control box.

There are automatic safety interlocks that control the heated hose, material pump and agitation systems. The agitator and pump will not work until the material has reached a pre-programmed temperature on the respective digital controllers. The heated hose must also be up to temperature before the pump can operate.

Once the material reaches the programmed temperature setting the agitator will automatically start turning. Opening the lid turns off the agitator. When adding material, open the lid and place a single block on it and push it closed. Do not add more than 4 boxes of material at a time.

A squealing noise indicates the blocks of material are not melted enough to agitate. Turn off the agitator control switch, wait 15 minutes and try again.

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## APPLICATION OF MATERIAL

**DO NOT MOVE THE HOSE UNTIL IT IS AT APPLICATION TEMPERATURE !**

Once the material in the tank is completely melted and the desired application temperature is reached, it is time to fill cracks.

Detach the hose from its storage holder, swing the boom into position. Under no circumstances must the hose be bent or kinked, this will destroy the hose.

Check to see that the pump switch located on the temperature control box is in the forward position, place the wand applicator head over the crack, press the pump activation switch on the wand. If no material comes out after 10 seconds, possibly the end of the applicator is plugged and may need cleaning.

Depress the pump activation switch for as long as necessary to keep the applicator full without overflowing it. With some experience you will know how far the material in the applicator head will go.

The speed of both the agitator and material pump motors can be fine tuned by adjusting the speed control knobs on the electro-hydraulic solenoid valve block.

The oil temperature controller should be set for 485°F.

The material temperature controller should be set for a mid range of the recommended pouring temperature on your products container.

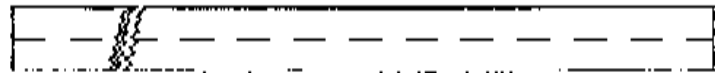
The hose temperature controller should be set for 350 to 400°F.

**See the temperature control page for instructions on how to set the controllers.**

Keep the volt meter at 120 volts while operating the hose. This is achieved by the engine throttle.

On a extremely cold and or windy day, all of the temperature settings may have to be increased to make up for heat losses.

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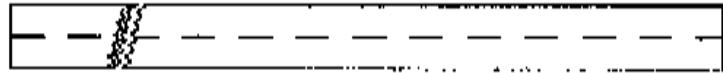


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Due to the fact there is not a valve on the end of the hose, material may continue to flow out even with the applicator switch not engaged. Place the applicator up in its holder for extended periods of non use. If or momentary non use, the pump switch on the controller box can be placed in the reverse position.



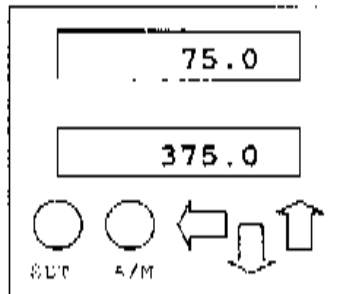
# Crack Pro



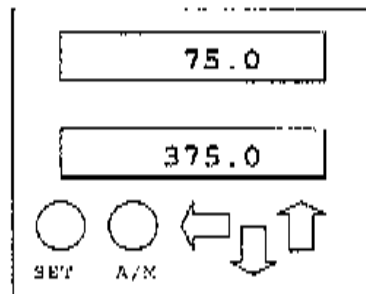
## TEMPERATURE CONTROL

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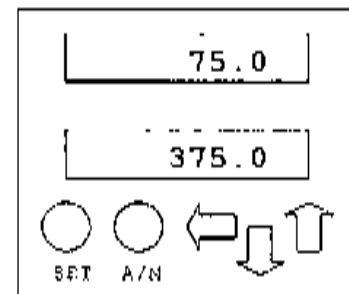
### TRANSFER OIL



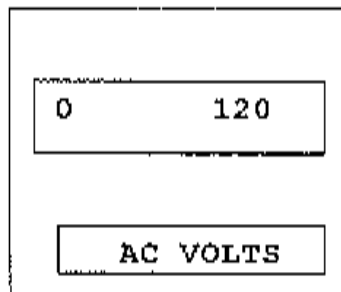
### MATERIAL



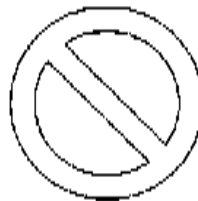
### HOSE



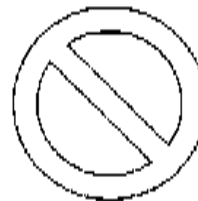
### VOLTMETER



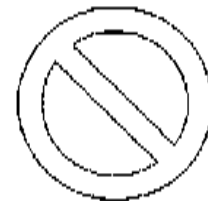
### AC POWER OFF ON



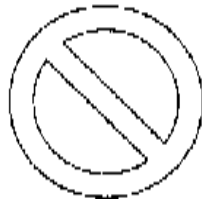
### PUMP FWD OFF REV



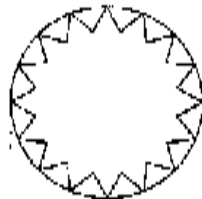
### AGITATION FWD OFF REV



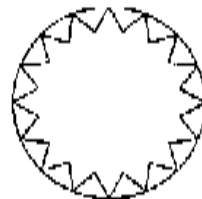
### POWER OFF ON



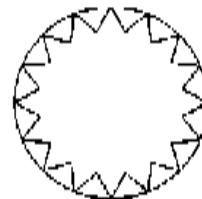
### BURNER ENABLE



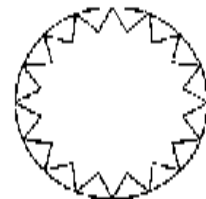
### HI TEMP



### RESET

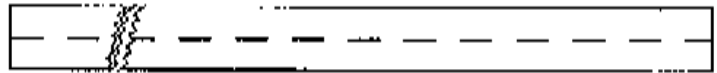


### INTERLOCKS



The top scale is the current temperature, the bottom scale is the temperature that you want to heat to. The burner shuts off when your setting is exceeded by 10 degrees. It comes back on when the temperature drops 10 degrees below your setting. The sequence for setting the temperature is: Press the left arrow 3 times, press up or down to get the 3, press the left arrow, then up or down to get the 7, press the left arrow, then up or down for the 5, then press set.

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## FLUID SPECIFICATIONS

Diesel engine crankcase oil:

The break-in oil should be changed after the first 50 hours of operation.

Oil change intervals:

Temperature	Oil type	Interval
Above 77°F	SAE 30 or 10w-30	with filter 100 hours
Between 32°F to 77°F	SAE 20 or 10w-30	with filter 100 hours
32°F or below	SAE 10 or 10w-30	with filter 100 hours

Hydraulic oil

The hydraulic system should be drained, cleaned, and refilled every two years. If the oil becomes contaminated at any time, flush the system immediately. The oil filter should be changed yearly. System capacity is 30 gallons.

Change the hydraulic oil filter after the first 20 hours of operation.

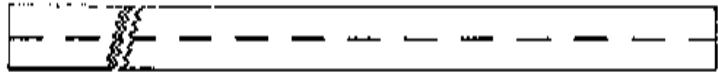
The factory installed oil meets the following specifications:

Grade 68  
Viscosity @ 100°F sus 352  
Approximate SAE grade 10W-20

Factory installed oil: ERC AW Hydraulic Oil

See enclosed MSDS

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## FLUID SPECIFICATIONS

Heat transfer oil is specially formulated to withstand high temperature and many heating and cooling cycles. The normal life cycle is one to two years, depending on how much the machine is used.

**Never leave the oil in the machine for more than two years.**

The procedure for checking the oil level is to **ALWAYS CHECK IT COLD.**

Located on the expansion tank is a oil level dip stick, there is a mark on the dip stick to designate the full point. When adding oil, it is necessary to remove the oil thermometer from the top rear curb side corner. Install a funnel here, and check with the dip stick.

**DO NOT OVER FILL, OVER FILLING WILL CAUSE OIL TO COME OUT THE OVERFLOW / VENT PIPE AND ONTO THE GROUND WHEN THE MACHINE IS BEING HEATED**

Oil coming out of the vent pipe means one of two reasons, over filling or moisture is present in the oil jacket. **Immediately shut off the burner if this happens. Let the machine cool completely.**

**Water in the oil is extremely dangerous. Never heat the machine if water is present. Drain and replace.**

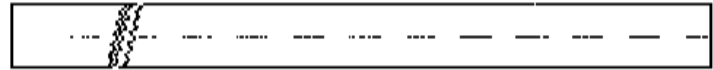
The factory installed oil meets the following specifications:

<b>Name</b>	<b>Industrial turbine oil</b>
<b>Flash point</b>	<b>&gt;390°F</b>
<b>Auto ignition temp.</b>	<b>&gt;500°F</b>

**Factory installed oil: Turbine XL 68**

**See enclosed MSDS**

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## SERVICE TIP FOR ENGINE START PUSHBUTTON

### A. ENGINE START-UP

Red pushbutton on panel must be held in the depressed position while starting engine until running oil pressure is established to open SWICHGAGE contacts.

(1) 518-APH pushbutton should remain in the depressed position during normal running.

If pushbutton fails to remain in the depressed position:

- (A) Visually check wiring for loose connections, frayed wiring, etc., on all terminals and switch loop circuit.
- (B) Check 14 amp fuse connected to "B" terminal.
- (C) Check for good ground on "G" terminal.
- (D) Disconnect switch loop circuit from SW1 and SW2 terminals. Place temporary jumper between SW1 and SW2 and restart engine. If pushbutton stays in with engine running, 518-APH switch is not the problem. This indicates either an open circuit, unwanted ground, or too high resistance in switch loop circuit wiring, between SW1 and SW2.
- (E) Continuity checks (power removed from (B) terminal).
  - (1) With ohmmeter or continuity light, check for good continuity through switch loop circuit. If good continuity is indicated, proceed to step (2).
  - (2) Unwanted ground in loop circuit.

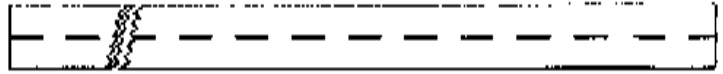
With SWICHGAGE contact adjusted away from pointer, check continuity between one end of loop circuit and ground. "Good continuity" indicates a unwanted ground in loop circuit such as a terminal rotated against mounting panel. Remove ground, restore loop circuit connections to SW1 and SW2, power to (B), restart engine.
  - (3) Too high resistance in switch wiring.

With ohmmeter check resistance between one end of loop circuit to the other. Resistance should exceed 25 ohms. If resistance is too high, recheck for loose connections in loop circuit. Otherwise select larger size wire for loop circuit.

### B. ENGINE SHUTDOWN

- (1) Engine fails to shutdown when contacts close on one wire to ground SWICHGAGE controls.
  - (A) With engine running, jumper SW1 to (C) terminal. If switch trips and engine shuts down, trouble is failure of SWICHGAGE contacts to make contact or lack of good case ground on SWICHGAGE. Adjust contacts back and forth to give a wiping and cleaning action on contacts. Check switch mounting for good ground.

# Crack Pro



Thr/Works Industries, Inc.  
Sandusky, Ohio  
(419) 626-4375

## TROUBLE SHOOTING GUIDE

MALFUNCTION	PROBABLE CAUSE	CORRECTIVE ACTION
<b>Material pump leaking</b>	Leaking around shaft	Tighten/replace packing
<b>No hose pressure</b>	Worn pump gears Worn hyd.motor Pump shaft not turning	Replace pump gears Replace hyd.motor Check wiring/fuse
<b>Diesel burner has Low operating psi</b>	Plugged fuel line Worn pump Pump coupler broken Burner motor worn	Clean or replace Check and replace Replace coupler Replace motor
<b>Burner won't light</b>	Plugged nozzle Electrodes worn @ tips Electrode spacing incorrect Fuel filter plugged Water in fuel Air in pump Transformer worn Primary control failed Fuel solenoid failed Worn pump Air shutter too far open No power from controller Burner locked out  Hi-temp light is on Cad cell dirty	Replace nozzle Replace electrodes Reset spacing Replace filter Replace fuel & filter Open bleeder Replace transformer Replace primary Replace solenoid Replace pump Reset to #8 Trace wires Disconnect battery Ground cable Push reset Clean or replace

**See oil burner trouble shooting guide for step by step instructions**

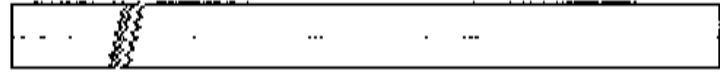
# Crack Pro

The Works Industries, Inc.  
Sandusky, Ohio  
(419) 626-4375

## TROUBLE SHOOTING GUIDE

<b>MALFUNCTION</b>	<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
<b>Engine won't start</b>	Dead battery Low on fuel Plugged fuel line Or filter Red over ride switch On engine start panel	Replace battery Fill fuel tank Clean fuel system change filter Must be pushed in when starting
<b>Heat transfer oil (HTO) not circulating</b>	Broken drive coupler Y-strainer plugged HTO line valves closed HTO line kinked Low on HTO HTO pump worn Drive motor worn	Change coupler Clean Y-strainer Open valves Replace line Check level and fill Replace pump Replace drive motor
<b>Hydraulic system Not working</b>	Low oil level Worn pump Filter plugged Tank valve closed Kinked hose	Check level and fill Replace pump Replace filter Open valve Replace hose
<b>Mixer not turning</b>	No power at 12 vdc coil Broken drive coupler Broken drive motor Hydraulic cartridge	Check wiring/fuse Replace coupler Replace motor Repair/replace
<b>HTO coming out of Vent pipe</b>	Over heated HTO Moisture in oil tank HTO past operating life	Check temp.control Drain and replace Drain and replace

# Crack Pro



ThorWorks Industries, Inc.  
Sandusky, Ohio  
(419) 626-4375

## MAINTENANCE SCHEDULE

	FIRST DAILY	WEEK	WEEKLY	ONE MTH	SIX MTH	ONE YEAR	TWO YEARS	
Check HTO level			*					
Change HTO							*	
Tighten pump Flanges		*		*				
Check ignitors						*	*	
Change primary Control						*		
Change solenoid						*		
Change nozzle						*		
Check hitch bolts		*		*	*			
Check material Hose clamps	*							
Change hyd.oil							*	
Check brakes							*	
Check tire psi		*		*	*			
Check lug bolts		*		*	*			
Check engine oil	*							
Pack wheel bearings							*	

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# Crack Pro

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Sandusky, Ohio  
(419) 626-4375

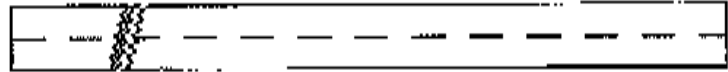
## PARTS LIST

REF #	DESCRIPTION	PART #	QTY
1	MATERIAL PUMP MOTOR	P474A035	1
2	CHAIN COUPLER	P630A007	1
	CHAIN COUPLER	P630A009	1
	COUPLER CHAIN	P631A001	1
3	HYDRAULIC MANIFOLD	P693A010	1
4	12 VOLT SOLENOID	P694A005	4
5	3" FLANGED GATE VALVE	P399A013	1
6	HOSE SWIVEL	P477A032	1
7	MATERIAL PUMP	P640A067	1
8	HEATED HOSE	P17582A006	1
9	BEARING	P435A003	2
10	TAIL LIGHT	P516A001	2
11	REFLECTOR-RED	P467A006	2
12	REFLECTOR-AMBER	P467A007	2
13	AMBER MARKING LIGHT	P467A002	2
14	3 BULB MARKER LIGHT	P467A003	1
15	FENDER-200/400 GALLON	P549A003	2
	FENDER-125 GALLON	P549A002	2
16	TOGGLE SWITCH BOOT	P443A004	1
17	TOGGLE SWITCH	P443A001	1
18	WATER TITE ENCLOSURE	P941A012	1
19	12" THERMOMETER	P659A006	1
20	18" THERMOMETER-125 GAL	P659A004	1
	24" THERMOMETER-200 GAL	P659A008	1
	36" THERMOMETER-400 GAL	P659A005	1
21	LID ASSEMBLY	N/A	1
22	AGITATOR MOTOR-125 GAL	P474A042	1
	AGITATOR MOTOR-200/400 GAL	P474A049	1
23	OIL EXPANSION TANK	P75000B005	1
24	OIL OVERFLO PIPE	P75000B006	1
25	OIL DIPSTICK	P75000B001	1
26	TYPE J THERMOCOUPLE	P679A005	2
27	TEMPERATURE CONTROLLER	P735A043	1
28	LID SWITCH	P442A010	1
29	TIRE/WHEEL ASS'Y 125 GAL	P514A017	2
	TIRE/WHEEL ASS'Y 200/400	P514A017	4
30	TORSION AXLE-4500LB-125 GAL	P511A032	1
	TORSION AXLE-3500LB-200 GAL	P511A016	2
	TORSION AXLE-5200LB-400 GAL	P511A017	2

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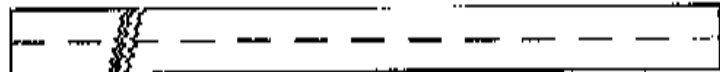
## PARTS LIST

ThorWorks Industries, Inc.  
Sandusky, Ohio  
(419) 626-4375

REF #	DESCRIPTION	PART #	QTY
31	LUGNUT	P579A003	24
32	DIESEL FUEL TANK	P74000B016	1
33	3/8" CLEAR TUBING	P716A024	2
34	3/8" HOSE END	P927A001	4
35	3/8" BALL VALVE	P397A005	1
36	AIR COMPRESSOR OPTIONAL	P458A072	1
37	N/A		
38	N/A		
39	DIESEL FUEL BURNER	P662A009	1
40	COMBUSTION CHAMBER LINER	P671A000	1
41	DIESEL ENGINE-125 GAL	P458A053	1
	DIESEL ENGINE-200/400 GAL	P458A054	1
	DIESEL ENGINE-COMPRESSOR	P458A063	1
42	VIBRATION ISOLATION MOUNT	P458B039	4
43	ENGINE COVER OPTIONAL	E2720	1
44	N/A		
45	SAFETY BREAKAWAY KIT	P518A001	1
46	3" PINTLE EYE	P646A002	1
47	2 5/16" BALL HITCH	P553A008	1
48	CHAIN HOOK	P517A001	2
49	3/8" SAFETY CHAIN	P531A036	2
50	TRAILER PLUG	P519A007	1
51	N/A		
52	N/A		
53	N/A		
54	TRAILER JACK	P551A001	1
55	BATTERY	P466A002	1
56	BATTERY CABLE 24"	P475B003	1
	BATTERY CABLE 31"	P475B004	1
57	HYDRAULIC OIL TANK	P74000B005	1
58	N/A		
59	N/A		
60	HOSE BOOM	P74000B007	1
61	WAND HOLDER BOX	N/A	1
62	TOOL BOX OPTION	P74000B004	1
63	FLANGE GASKET	P479A006	2

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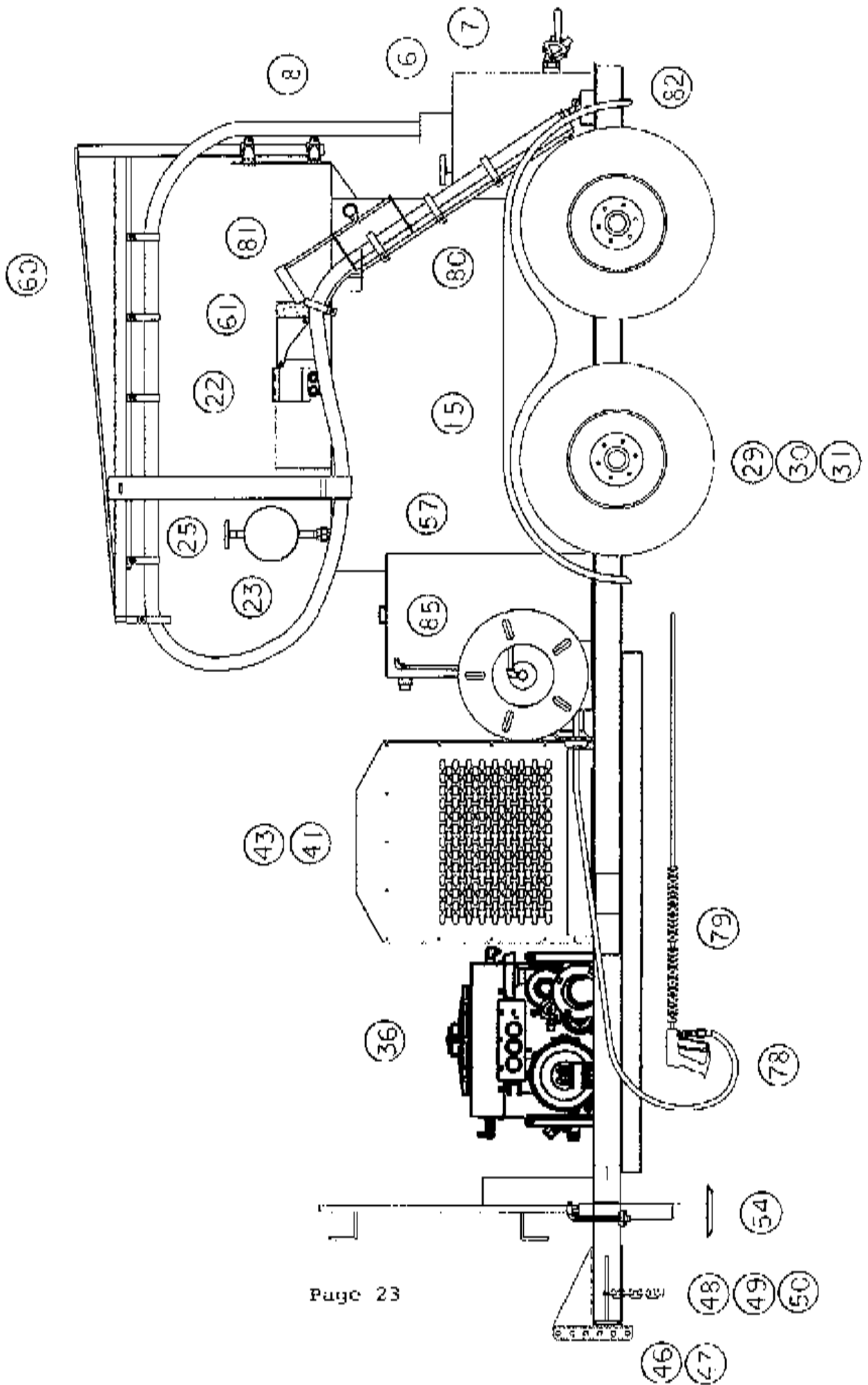


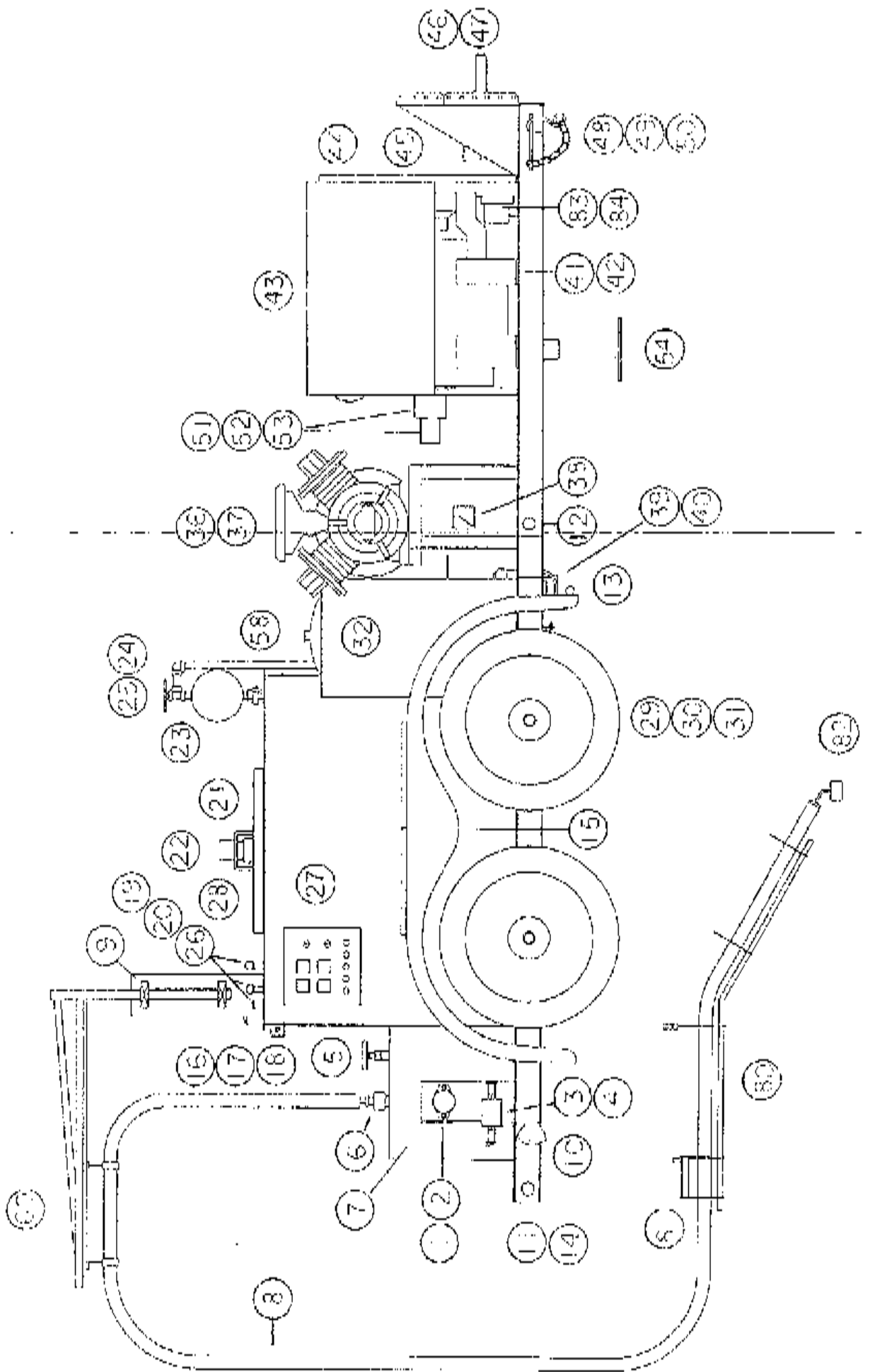
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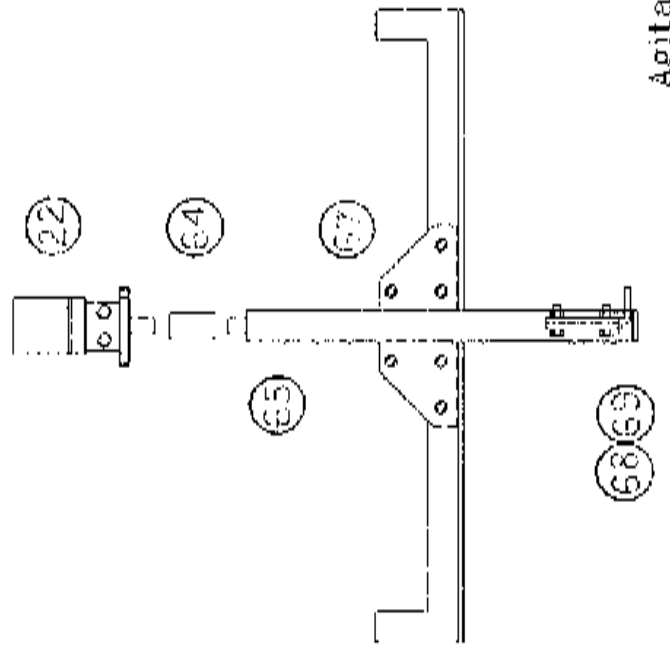
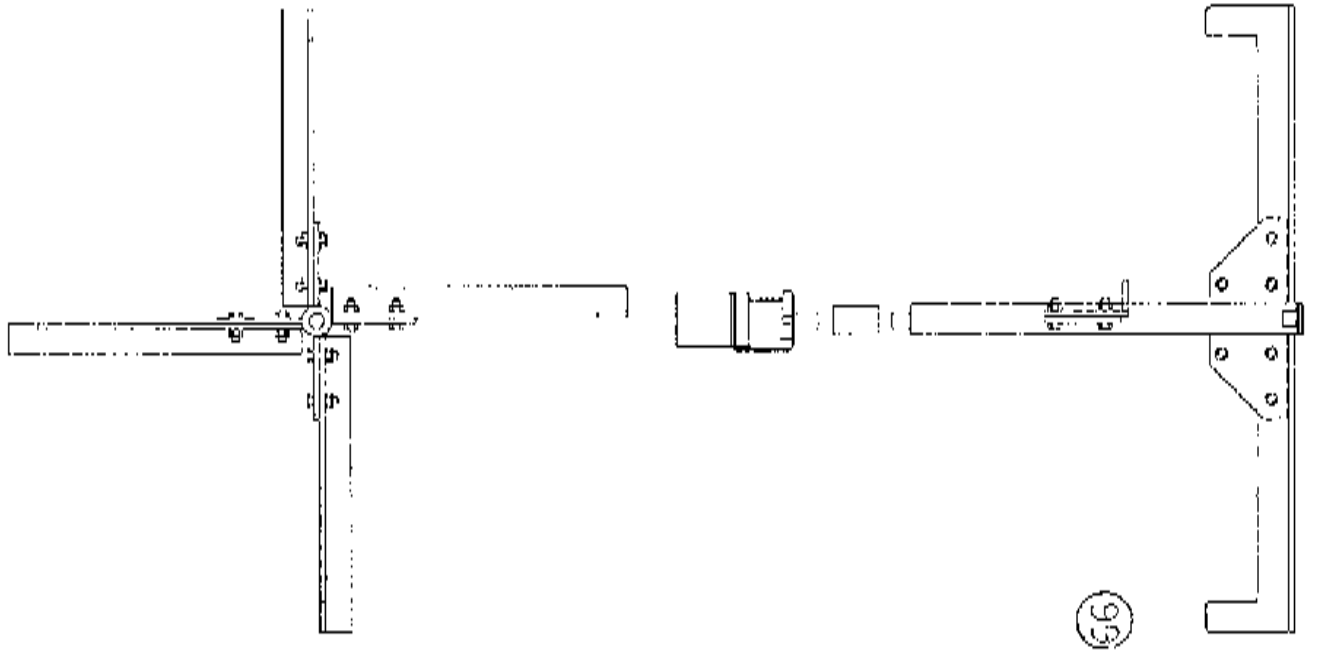
## PARTS LIST

REF #	DESCRIPTION	PART #	QTY
64	SPLINED COUPLER-125 GAL	P630A043	1
	SPLINED COUPLER-200/400 GAL	P630A047	1
65	AGITATOR SHAFT-125 GAL	P74000B008	1
	AGITATOR SHAFT-200 GAL	P74000B009	1
	AGITATOR SHAFT-400 GAL	P74000B010	1
66	AGITATOR ARM-125 GAL	P74000B011	2
	AGITATOR ARM-200 GAL	P74000B012	4
	AGITATOR ARM-400 GAL	P74000B013	4
67	ARM SUPPORT	P74000B014	4
68	PIVOT PIN	P74000B015	1
69	PIVOT PIN BUSHING	P439A004	1
70	HYDRAULIC TANK CAP	P464A002	1
71	DIESEL TANK CAP	P464A003	1
72	HYDRAULIC OIL FILTER	P908A003	1
73	OIL FILTER HEAD	P909A002	1
74	3/4" GATE VALVE	P399A002	1
75	N/A		
76	DIESEL FUEL FILTER	P463A001	1
77	N/A		
78	5/8" X 100' AIR HOSE	P717A007	1
79	AIR WAND	P632A000	1
80	MATERIAL WAND	P74000D001	1
81	PUMP SWITCH	P443A009	1
82	APPLICATOR SHOE	P163A012	1
83	GENERATOR	P695A001	1
84	V-BELT	P660A035	2
85	HOSE REEL	P901A042	1
	HYDRAULIC OIL	P938A009	25 GAL.
	HEAT TRANSFER OIL 125 GAL	P938A008	25 GAL
	HEAT TRANSFER OIL-200 GAL	P938A008	28 GAL
	Heat Transfer Oil-260 Gal	P938A008	30 Gal
	HEAT TRANSFER OIL-400 GAL	P938A008	45 GAL.

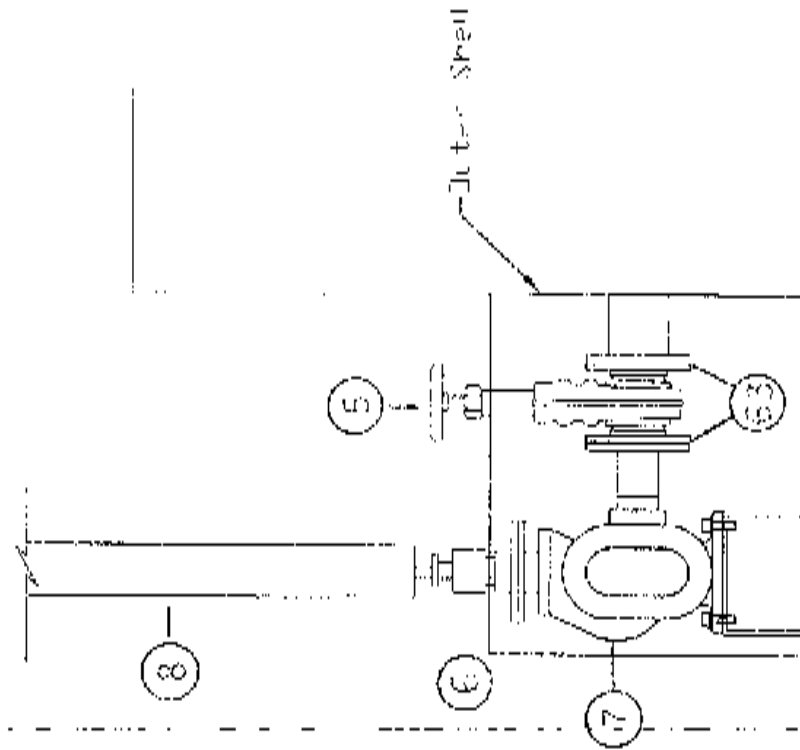
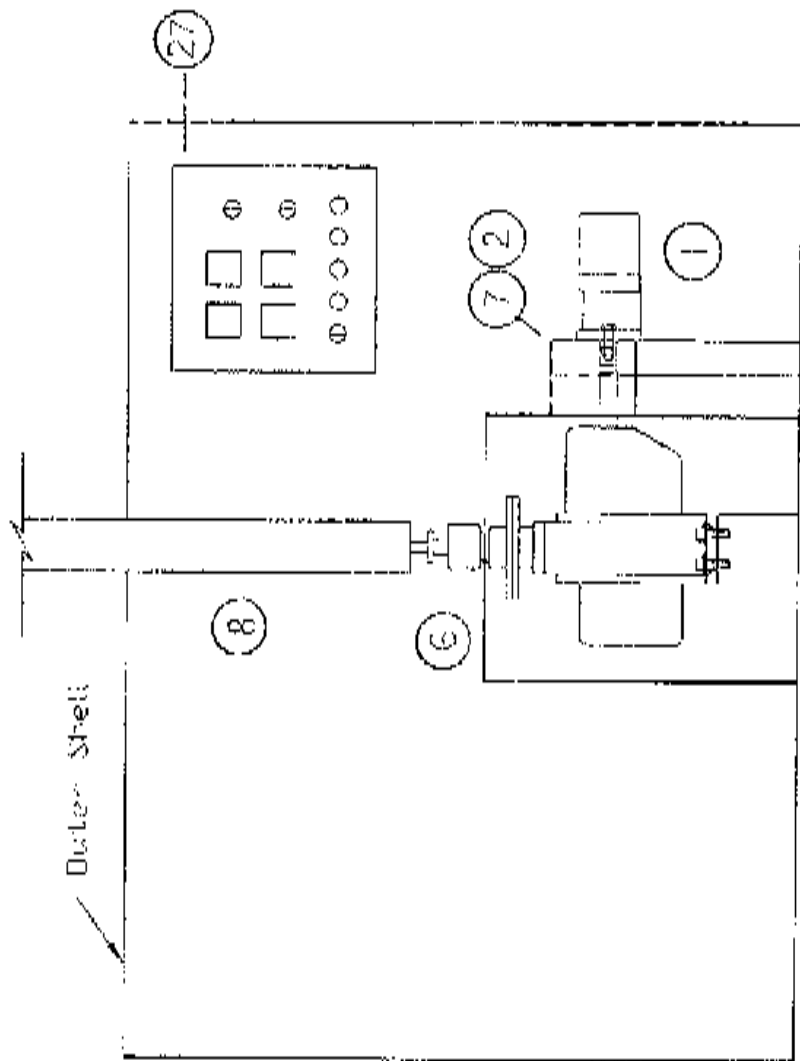
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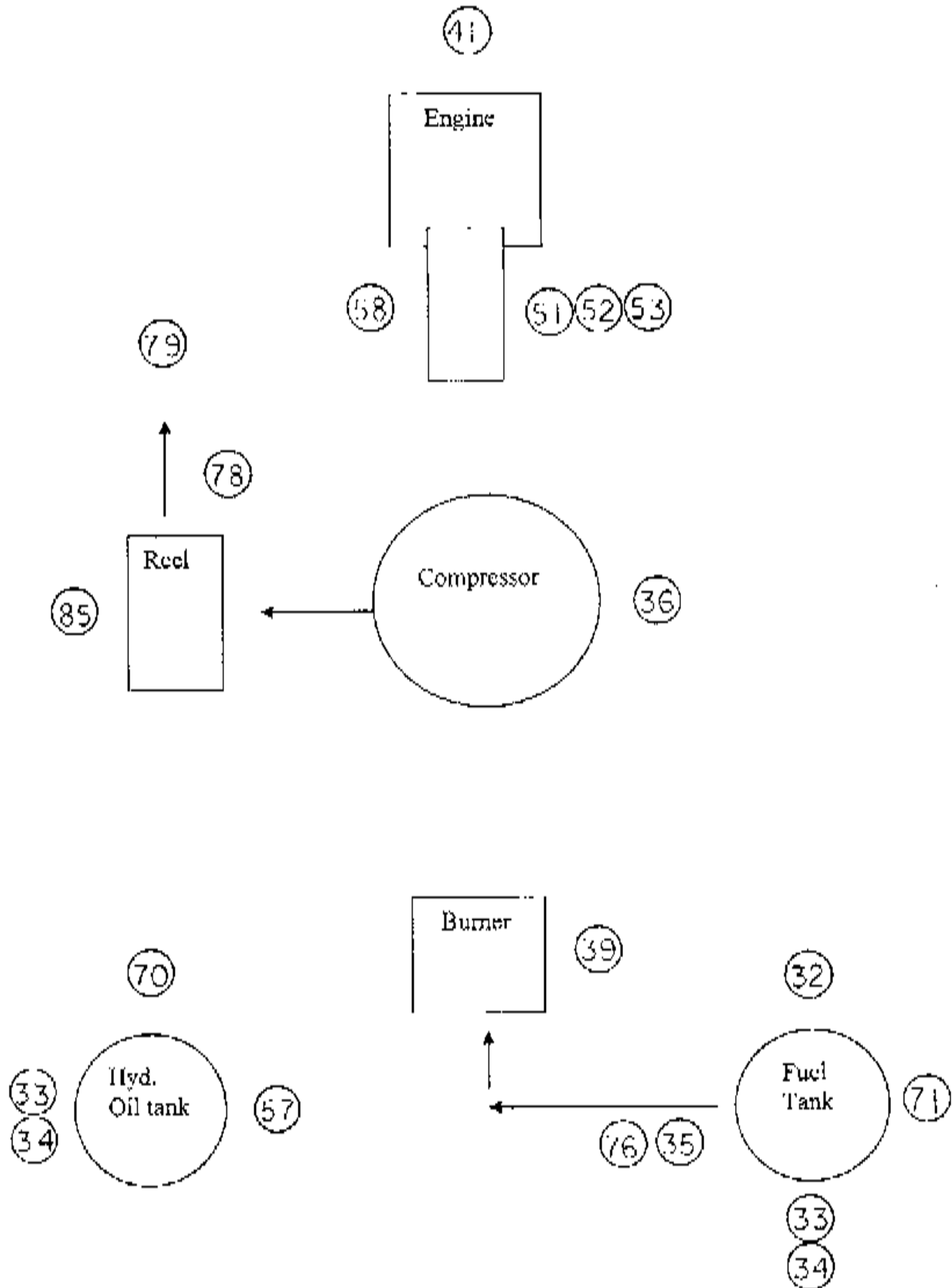


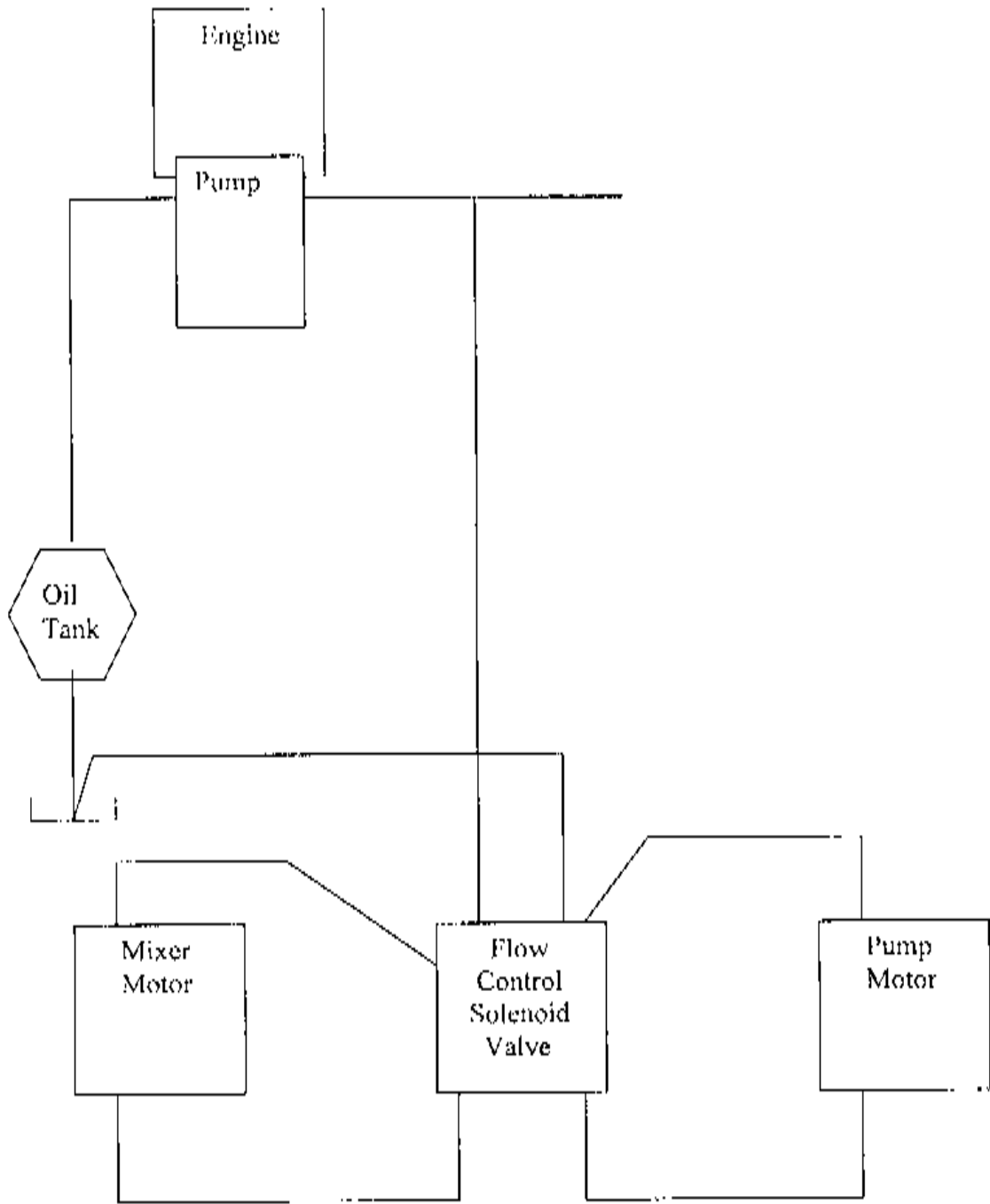
Agitator Assembly



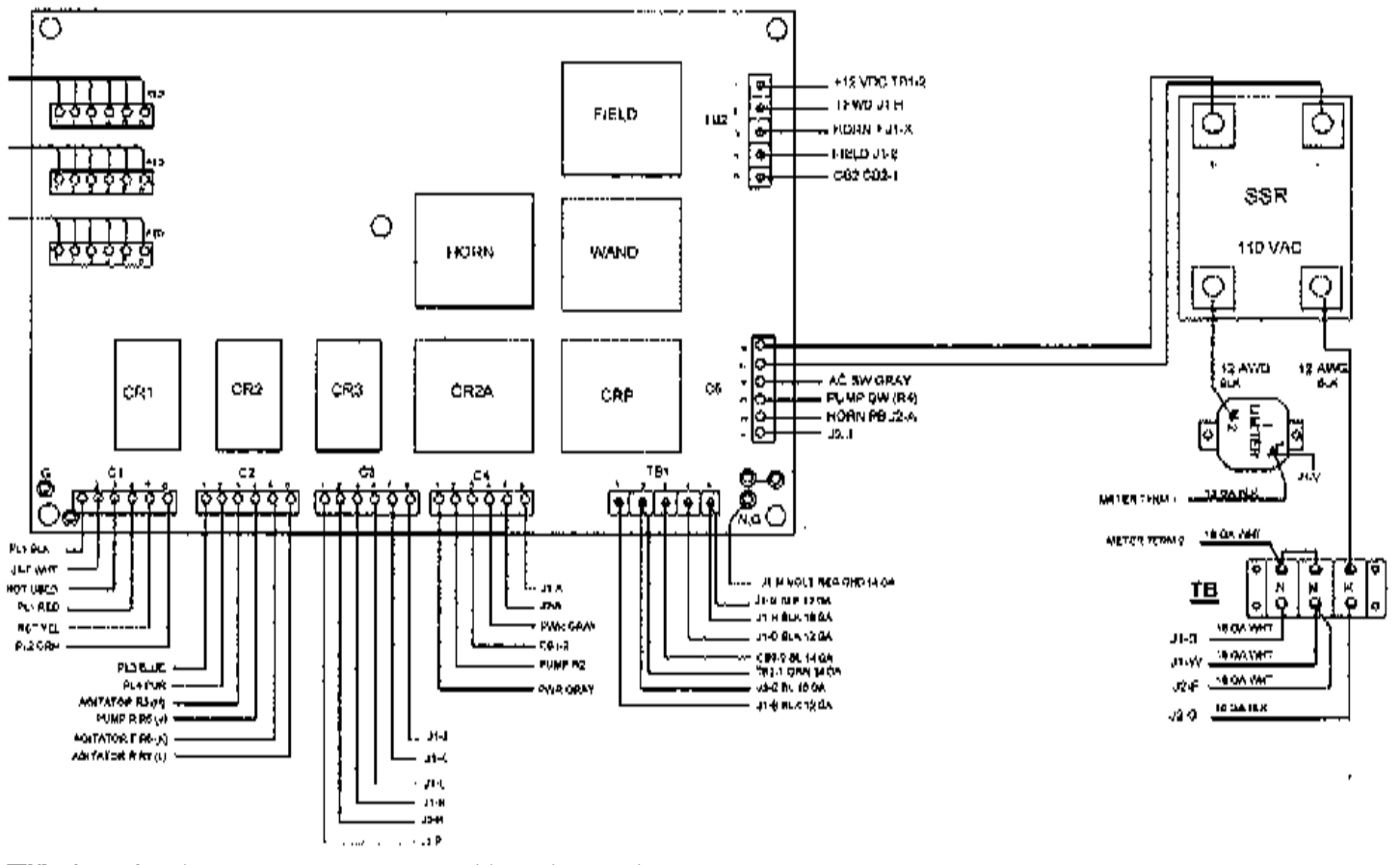
Piping Layout

Diesel & Pneumatic Schematic









Revision	Date	Description	By
1	0-16-2012	ISSUED FOR PRODUCTION	FJK

**REVISION HISTORY**

TOLERANCES UNLESS OTHERWISE SPECIFIED			
FABRICATED PARTS TOLERANCE			
ANGULAR	± 1°	1 PLACE	± 0.1°
FRACTIONAL	1/16"	2 PLACE	± 0.06"
FEET & INCH	1/4"	3 PLACE	± 0.032"
MACHINED PARTS TOLERANCE			
ANGULAR	± 1°	1 PLACE	± 0.01°
		2 PLACE	± 0.003°

**QUEUE ENGINEERING LLC**

**THORWORKS INDUSTRIES**

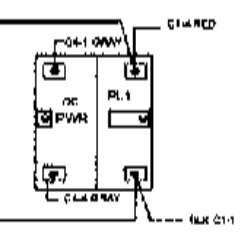
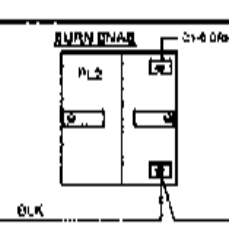
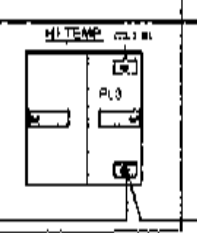
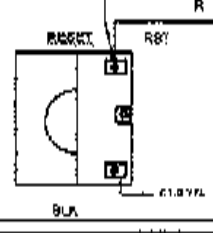
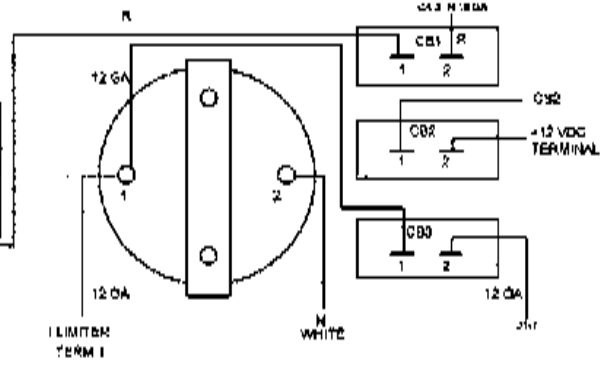
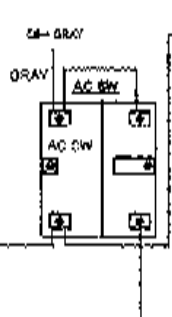
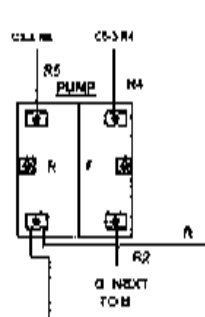
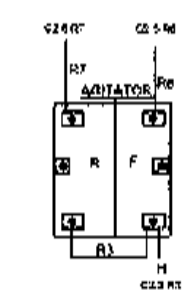
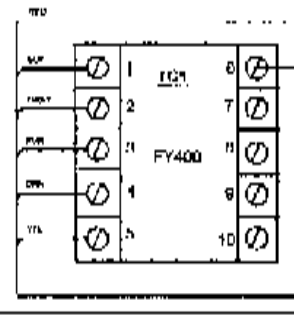
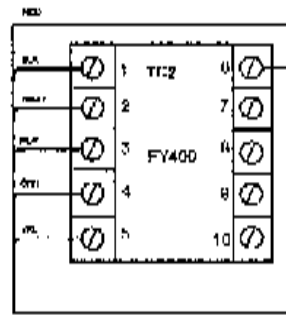
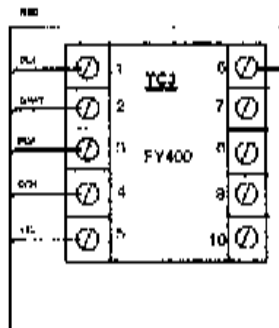
**HEATED HOSE WIRING DIAGRAM**

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DATE: 0-16-2012  
SCALE: AS SHOWN

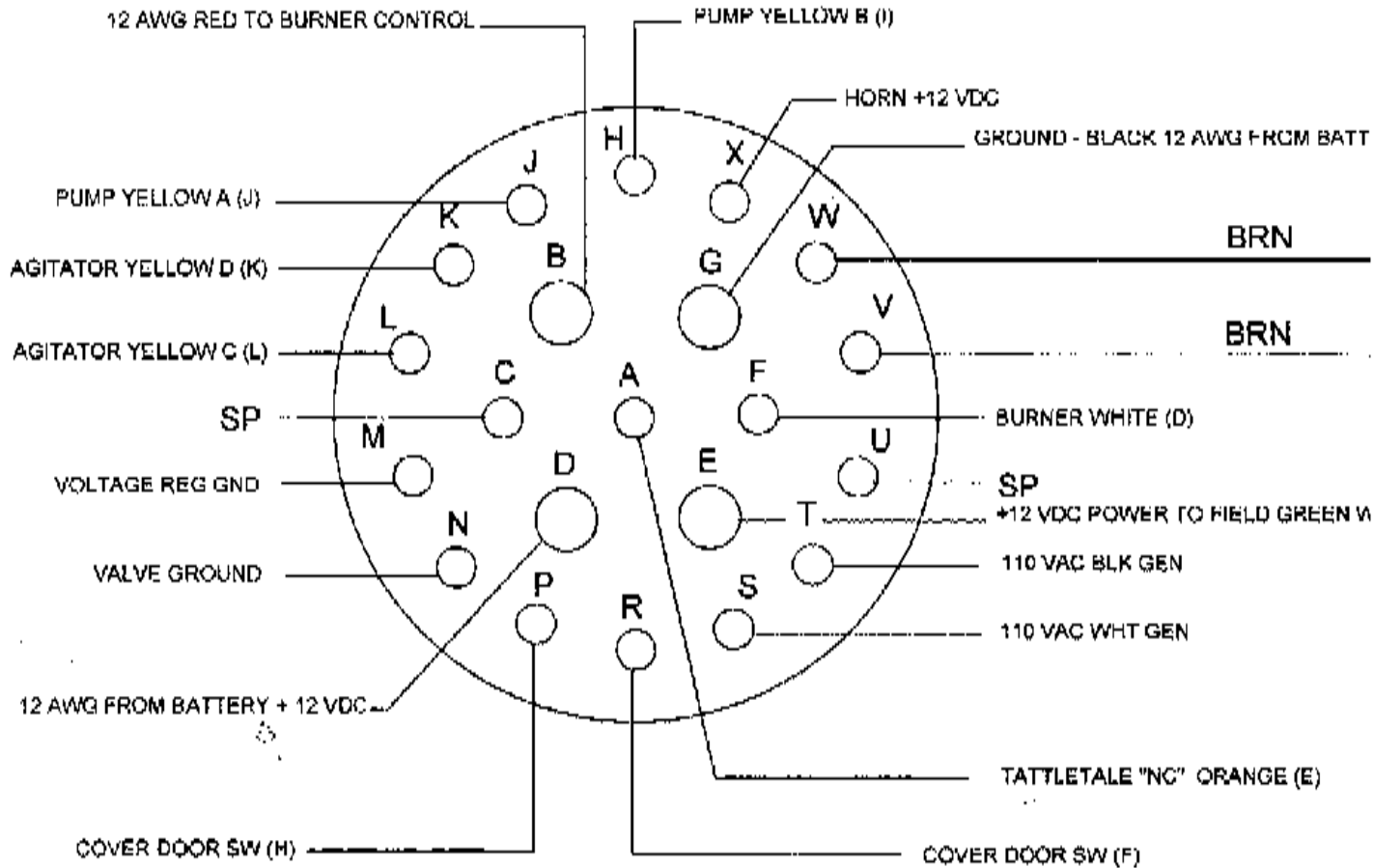
FILENAME: [Blank]







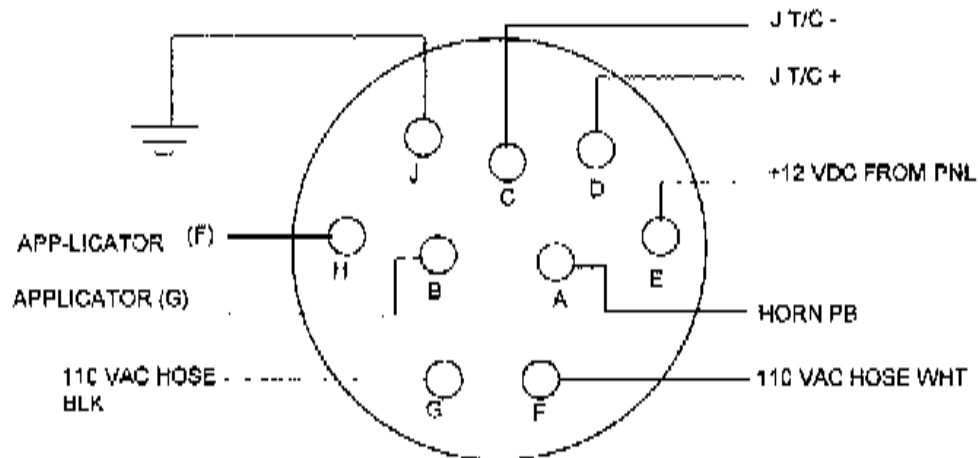
# J1



**P/N 25-HD34-24-21PN**

BLACK WIRE #10 TO BURNER CONTROL DIRECT FROM BATTERY

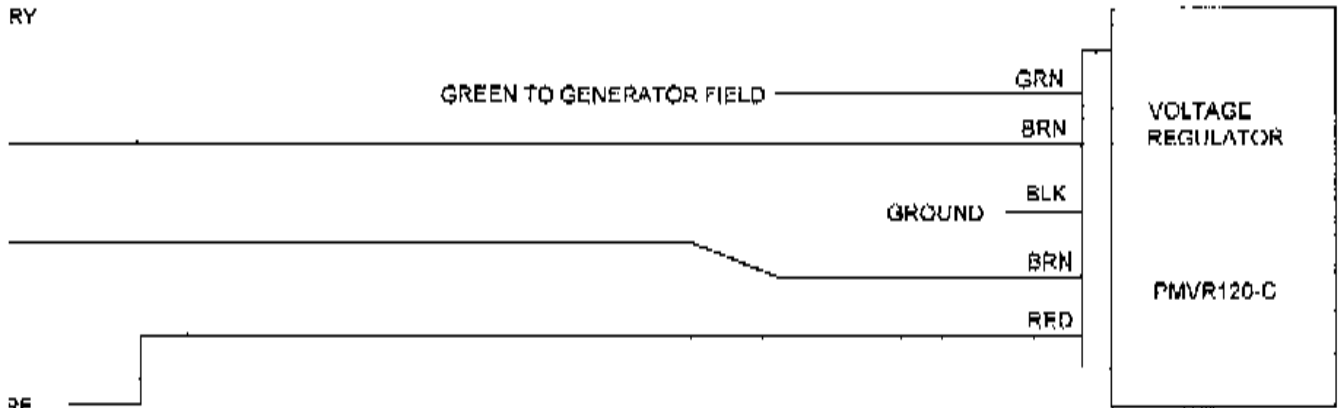
# J2



**P/N HD10-9-96P**

NOTE:  
ALL POWER MUST BE OFF BEFORE PLUGGING AND  
UNPLUGGING THE  
MAIN CONNECTOR





**WIRING WHEN VOLTAGE  
REGULATOR IS USED**

Revision	Date	Description
1	9/19/12	ISSUED TO MOUNTING

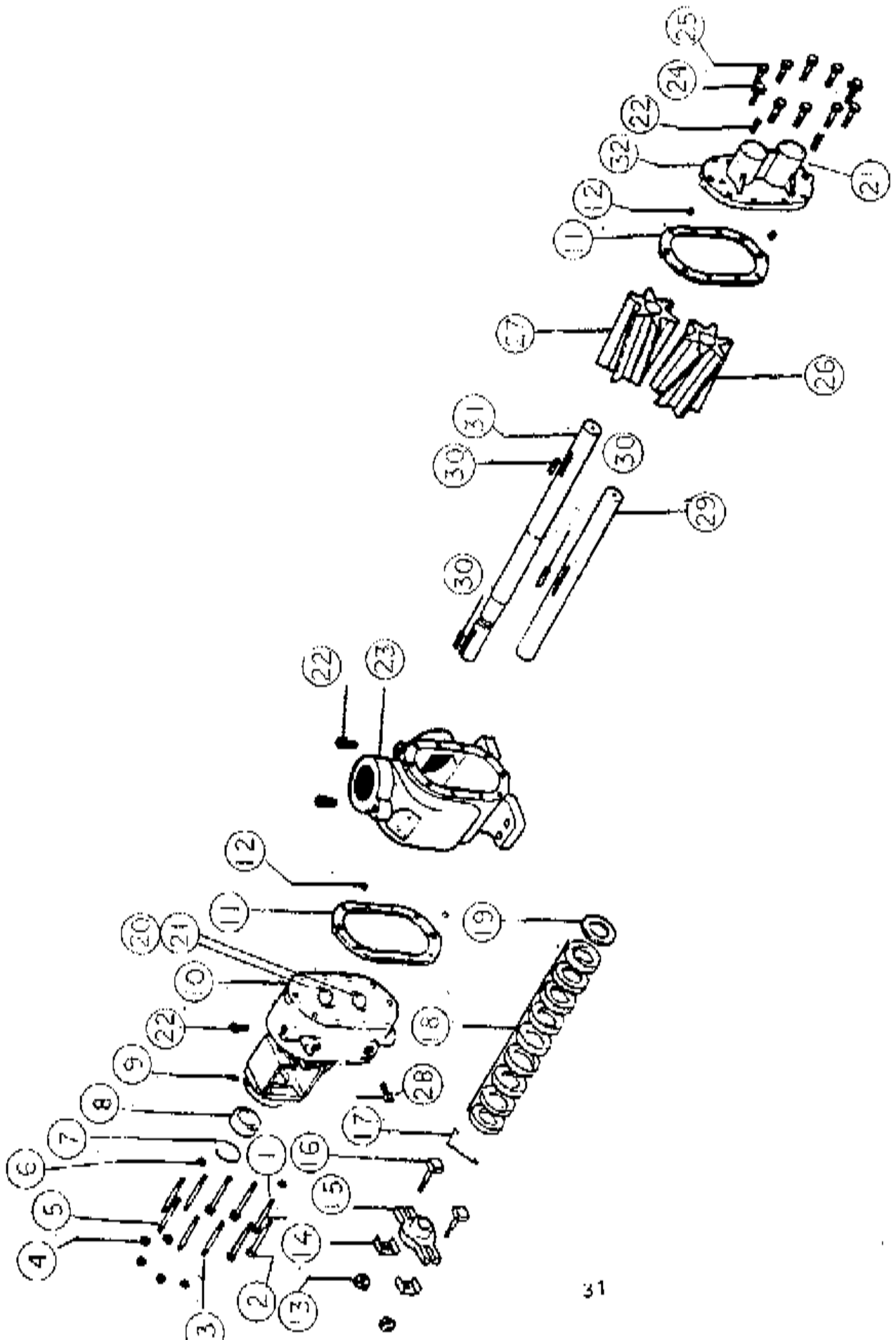
**TOLERANCES  
UNLESS OTHERWISE SPECIFIED**

FABRICATED PARTS TOLERANCES		
ANGULAR	± 1°	1 PLACE ± 0.1°
FRACTIONAL	± 1/16"	2 PLACE ± 0.007"
DECIMAL INCH	± 1/4"	3 PLACE ± 0.002"
MACHINED PARTS TOLERANCES		
ANGULAR	± 1°	1 PLACE ± 0.01°
		2 PLACE ± 0.002°

STANDARDS	
CE	
<b>QUEUE ENGINEERING LLC</b>	
<b>THORWORKS INDUSTRIES</b>	
<b>HEATED HOSE MAIN CONNECTOR</b>	
90 30 10	
<small>This drawing is confidential and subject to patent. It shall not be copied, reproduced or used for any purpose without written consent of Queue Engineering LLC. All rights reserved.</small>	
Drawn by: <b>FJK</b> Date: <b>3-22-2012</b> Scale:	Checked by:
SHEET NO.	
Scale:	







## 18. DIMENSIONAL DATA FOR INTERNAL PARTS

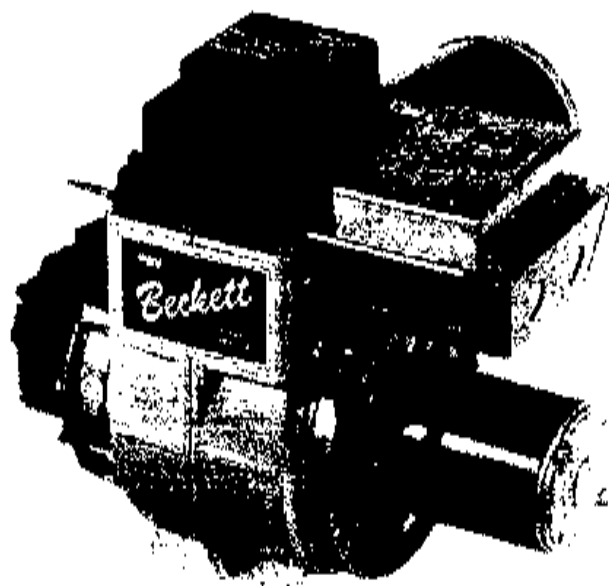
Nominal dimensions are given below. With the exception of gasket thickness and lateral clearance, your actual measurements should not vary from these numbers by more than .002". Use properly calibrated measuring equipment when measuring parts.

ITEM	PUMP SIZE		
	11	17	22
Bore for Bearings	1.4375	1.4375	1.4375
Shaft O.D.	1.0620	1.0620	1.0620
Case Bores	3.8490	3.8490	3.8490
Gear O.D.	3.8410	3.8410	3.8410
Gear O.D. to Case Bore Diametral Clearance	.0080	.0080	.0080
Bronze Bearing O.D.	1.4385	1.4385	1.4385
Bronze Bearing Press Fit	.0010 min.	.0010 min.	.0010 min.
Bronze Bearing I.D. (Free)	1.0680	1.0680	1.0680
Bronze Bearing I.D. (Installed)	1.0670	1.0670	1.0670
Shaft to Bronze Bearing Diametral Clearance	.005	.005	.005
Iron Bearing O.D.	1.4385	1.4385	1.4385
Iron Bearing Press Fit	.0010 min.	.0010 min.	.0010 min.
Iron Bearing I.D. (Free)	1.0675	1.0675	1.0675
Iron Bearing I.D. (Installed)	1.0665	1.0665	1.0665
Shaft to Iron Bearing Diametral Clearance	.0045	.0045	.0045
Carbon Bearing O.D.	1.4400	1.4400	1.4400
Carbon Bearing Press Fit	.0025 min.	.0025 min.	.0025 min.
Carbon Bearing I.D. (Free)	1.0710	1.0710	1.0710
Carbon Bearing I.D. (Installed)	1.0690	1.0690	1.0690
Shaft to Carbon Bearing Diametral Clearance	.0067	.0067	.0067
Case Width	2.994	4.494	5.994
Gasket Thickness (One)	.012	.012	.012
Compressed Gasket Thickness (Two)	.016	.016	.016
Gear Face Width	3.001	4.501	6.001
Lateral Clearance (Two Compressed Gaskets)	.009	.009	.009

# MODEL **ADC** Oil Burner

## Instruction Manual

Type "F" air tube combinations



Thank you for purchasing a Beckett burner. With proper care and regular maintenance, it will provide years of trouble-free service. Please take a few minutes to read the section entitled 'To the Owner' inside this manual. Then, keep the manual in a safe place where it can be easily located if needed by your professional service technician.

**Contents**

<b>1. Prepare before installing</b>	
A. Verify specifications	3
B. Be aware of hazard definitions	3
C. Notice special requirements	3
<b>2. General information</b>	
A. Equipment located in confined space	4
B. Exhaust fans and other air-using devices	4
C. Clearances to burner and equipment	4
D. Exhausting hazardous fumes	4
E. Low firing rate baffle	4
<b>3. Nozzle, Line, Electrode, &amp; Igniter Maintenance</b>	
A. Nozzle Assembly Maintenance	5
B. Replace Burner Nozzle	5
C. Check & Adjust Electrodes	6
D. Igniter Maintenance	6
E. Nozzle Line Assembly Maintenance	6
F. Check & Adjust 'Z' Dimension	6
<b>4. Fuel Supply Maintenance</b>	
A. Connect Fuel Lines	7
B. Fuel Supply Level or Above Burner	7
C. Fuel Supply Below Level of Burner	7
D. Fuel Line Replacement	7
E. Fuel Line Valve and Filter	7
<b>5. Burner Maintenance and Wiring</b>	
A. Burner installed on washer	7
B. Replacement Burner Installation	7
<b>6. Drive Component Maintenance</b>	
A. Motor, Blower Wheel, and Coupling Replacement	9
B. Pump Maintenance and Replacement	10
C. Valve Replacement	10
<b>7. Start up Burner and Set Combustion</b>	
A. Basic burner operation	11
B. Combustion set up	11
C. Set combustion with test instruments	11
<b>Appendix A. Maintain &amp; Service burner</b>	
A. Owner's information	12
B. Owner Service & Maintenance	12
C. Daily Maintenance	12
D. Weekly Maintenance	12
E. Regular Service/Maintenance	12
<b>Appendix B. Burner Troubleshooting</b>	
Troubleshooting Chart	13
<b>Appendix C. Replacement Parts</b>	
Burner Exploded View	15

## 1. Prepare before installing

### A. Verify specifications

<b>Capacity</b>	"F" heads Firing rate ..... 0.75 – 2.50 GPH Input ..... 105,000 – 350,000 Btu/h
<b>Fuels</b>	U. S. .... No. 1 or No. 2 diesel fuel, or kerosene – No. 1 or No. 2 heating oil (ASTM D396)
<b>Electrical</b>	Power supply ..... 13.5 VDC Operating load ..... 15 Amps w/ igniter on, 8-10 Amps w/ igniter turned off Motor ..... 13.5 VDC, 1/8 hp, 3450 rpm, 10 Amps (max.), NEMA "M" flange, rotation CCW when facing shaft end Ignition Secondary ..... 20KVpk 30mA - Interrupted duty OR optional continuous duty
<b>Pump</b>	Outlet pressure ..... Note 1
<b>Air tube</b>	ATC code ..... See Table 1
<b>Dimensions</b>	Height (maximum) ..... 11 1/2 inches Width (maximum) ..... 14 3/8 inches Depth (chassis only) ..... 6 9/16 inches Air tube diameter ..... 4 inches
<b>Temperature</b>	150° Max air temperature
Note 1. See equipment manufacturer's burner specifications for recommended outlet pressure. Pressure is 100 psig unless otherwise noted.	

Table 1—Air Tube Combination (ATC) codes\*

Firing rate (gph) (min-max)	Head	Static plate size (inches)	ATC codes for usable air tube lengths: ("A" in inches; see Figure 2)			
			4 1/2	5	5 3/4	6 1/2
0.40-0.75	F0	3 3/4 U	AF44XR	-	AF53XR	AF65XR
0.75-1.25	F3	2 3/4	AF44XN	-	AF53XN	AF65XN
0.85-1.35	F4	2 3/4	AF44WH	-	AF53WH	AF65WH
0.85-1.65	F6	2 3/4	AF44YB	-	AF53YB	AF65YB
1.10-2.00	F12	2 3/4	AF44XO	-	AF53XO	AF65XO
1.65-2.50	F22	2 3/4	AF44XP	-	AF53XP	AF65XP

### B. Be aware of hazard definitions

#### DANGER

Denotes presence of a hazard which, if ignored, will result in severe personal injury, death, or substantial property damage.

#### WARNING

Denotes presence of a hazard which, if ignored, could result in severe personal injury, death, or substantial property damage.

#### CAUTION

Denotes presence of a hazard which, if ignored, could result in minor personal injury or property damage.

#### NOTICE

Intended to bring special attention to information, but not related to personal injury or property damage.

### C. Notice special requirements

#### DANGER

- This equipment must be installed, adjusted and started only by a **qualified service agency** – an individual or agency, licensed and experienced with all codes and ordinances, who is responsible for the installation and adjustment of the equipment. **All oil burners should be installed in accordance with regulations of the latest revision of the National Fire Protection Association Standard NFPA 31 and in complete accordance with all local codes and authorities having jurisdiction. Regulation of these authorities take precedence over the general instructions provided in this installation manual. Note that this burner is NOT recommended for Residential use.**

- For recommended installation practice in Canada, refer to the latest version of CSA Standard B139.

#### WARNING

**Read all instructions before proceeding.** Follow all instructions completely. Failure to follow these instructions could result in equipment malfunction, causing severe personal injury, death or substantial property damage.

#### NOTICE

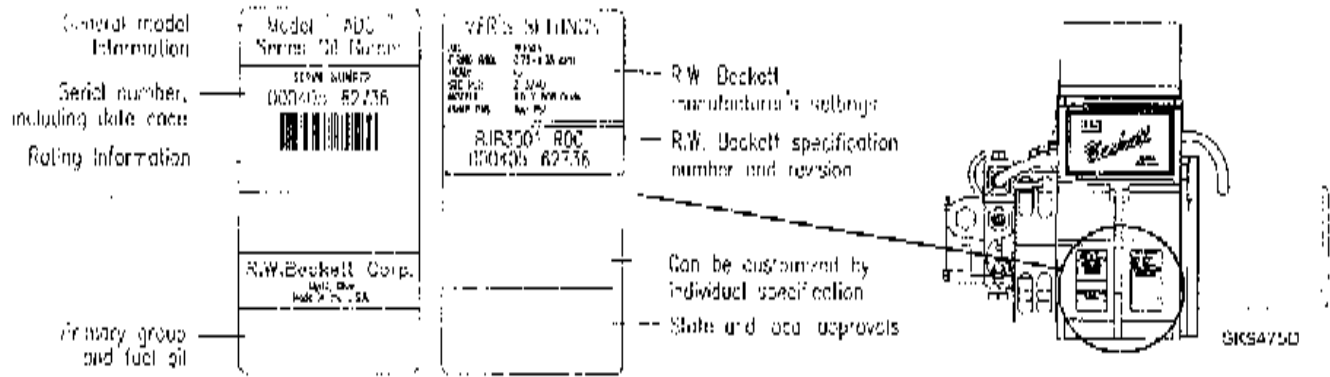
**Concealed damage** — If you discover damage to the burner or controls during unpacking, notify the carrier at once and file the appropriate claim.

#### NOTICE

When contacting Beckett for **service information** – Please record the **burner serial number** (and have available when calling or writing). You will find the serial number on the silver label located on the left rear of the burner. See illustration below.

## Instruction Manual – Model ADC Oil Burner

Figure 1 – Typical Burner Nameplates



## 2. General information

Your burner was designed, installed and adjusted at the factory prior to shipment and should not require additional adjustments. Refer to the Troubleshooting section of this manual when experiencing a possible fault condition.

### **DANGER**

The Model ADC Burner requires a continuous supply of 11 to 16 volts DC at 15 amperes measured at the burner during operation. An automotive or a small engine charging system that is capable of supplying the required continuous voltage/ampereage is recommended with certain road equipment, such as asphalt hot patchers and similar applications. This is especially true while maintaining nominal load temperatures during idle periods. A low or erratic power supply could result in impaired burner operation, severe delayed ignition or an explosion inside the heat exchanger resulting in a burn and/or asphyxiation hazard.

### **WARNING**

If the burner is not supplied with a reliable combustion air source, the burner cannot properly burn the fuel. This would result in incomplete combustion, causing sooting and probable emission of carbon monoxide. Severe personal injury, death or substantial property damage could occur.

Burner head type	Low Firing Rate Baffle, if specified:
F0	up to 0.65 gph
F3	up to 0.85 gph
F4 or F6	up to 0.90 gph

### A. Equipment located in confined space

The confined space should have two (2) permanent openings: one near the top of the enclosure and one near the bottom of the enclosure. Each opening shall have a free area of not less than (1) one square inch per 1,000 BTU's per hour of the total input rating of all equipment within the enclosure. The openings shall have free access to the building interior, which should have adequate infiltration from the outside.

### B. Exhaust fans and other air-using devices

(Typically not used)

Size air openings large enough to allow for all air-using devices in addition to the minimum area required for combustion air. If there is any possibility of the equipment room developing negative pressure (because of exhaust fans, for example), either pipe combustion air directly to the burner or provide a sealed enclosure for the burner and supply it with its own combustion air supply.

### C. Clearances to burner and equipment

- Provide space around burner and equipment for easy service and maintenance.
- Check minimum clearances against those shown by the equipment manufacturer and by applicable codes.

### D. Exhausting Hazardous Fumes

An asphyxiation hazard could exist due to improper combustion levels that impair proper burner operation. Copious amounts of smoke and carbon monoxide could be produced in a confined area. Also, be conscious of any fumes produced by the materials that are being heated. Always ensure adequate ventilation to exhaust all fumes.

### E. Low Firing Rate Baffle

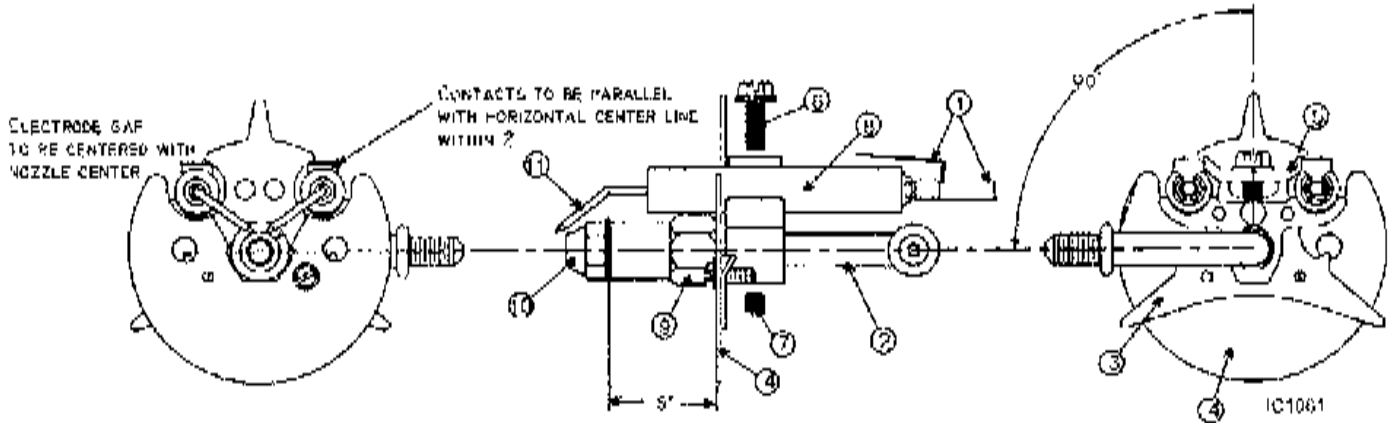
The Low Firing Rate Baffle (LFRB) (see Replacement Parts) reduces the air flow and pressure. The LFRB is sometimes used for firing rates under 1.00 GPH as listed in the table below. Refer to the equipment manufacturer's instructions. Do not omit the LFRB when specified. Omitting the baffle when specified or installing the baffle when not specified could result in poor burner performance.

### 3. Nozzle, Nozzle Line, & Electrode Maintenance

#### A. Nozzle Maintenance

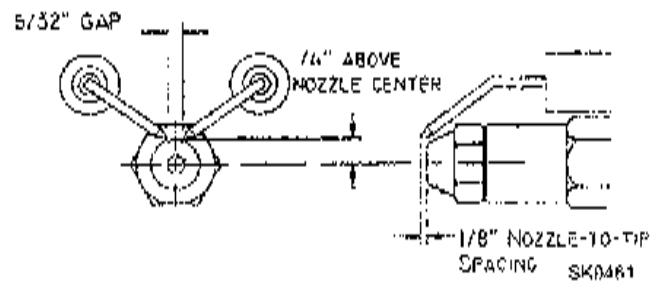
Refer to the following figure for nozzle, nozzle line and electrode familiarization.

Figure 2 Nozzle, line & electrode assembly



Item #	Description
1	Electrode Contact (3" ATC or Extension over 3")
2	Nozzle Line
3	Spider Spacer Assembly
4	Static Plate
5	Electrode Clamp
6	Electrode Clamp Retaining Screws
7	Nozzle Line Setscrew
8	Electrode Insulator
9	Nozzle Adapter
10	Nozzle Tip
11	Electrode Tip

Figure 3 – Electrode Tip Settings



#### B. Replace burner nozzle

##### WARNING

Make certain the correct nozzle is selected for the actual pump pressure. Nozzles are rated for 100 psig operation. For applications with pump pressure above 100 psig, the nozzle rated capacity will be lower than the equipment firing rate. Use only the specified spray pattern. Failure to use the correct nozzle size and type can result in unacceptable combustion, possibly causing severe personal injury, death or substantial property damage.

1. If applicable, remove the plastic plug protecting the nozzle adapter threads.
2. Place a 3/4" open end wrench on the nozzle adapter. Insert the nozzle into the adapter and finger tighten. Finish tightening with a 3/4" open end wrench.
3. If the nozzle is already installed, remove the nozzle line assembly to verify that the nozzle size and spray pattern are correct for the application (per equipment manufacturer's information). Verify that the electrode tip settings comply with Figure 3.

##### CAUTION

Use care when removing and installing oil nozzles.

- Inspect the nozzle adapter prior to installing the nozzle. If the sealing surface is grooved or scratched, replace the nozzle line assembly. If a damaged nozzle adapter is not replaced, oil could leak at the nozzle-adapter joint, causing serious combustion problems.
- Protect the nozzle orifice and strainer when installing a nozzle. If there is dirt in the orifice or it is scratched or damaged, the nozzle will not function properly.
- Do not over torque the nozzle when installing. This will cause deep grooves in the nozzle adapter, preventing a seal when a new nozzle is installed.
- Use a wrench that secures the adapter or use 3/4" and 5/8" open-end wrenches. DO NOT attempt to remove or install a nozzle without securing the adapter. The nozzle alignment could be seriously damaged.
- Do not squeeze the electrodes too tightly when handling the nozzle line assembly. This could change the electrode tip settings or damage the ceramic electrode insulators.

## Instruction Manual – Model ADC Oil Burner

- Carefully check and realign electrode tips after replacing the nozzle, ensuring the electrode settings comply with Figure 3.

### C. Check/adjust electrodes

Check the electrode tip settings. Adjust if necessary to comply with the dimensions shown in Figure 3. To adjust, loosen the electrode clamp screw and slide/rotate electrodes as necessary. Securely tighten the clamp screw when finished.

### D. Igniter Maintenance

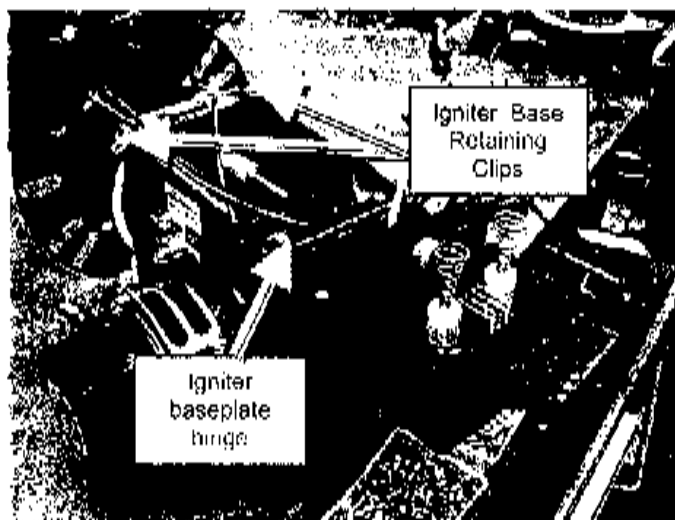
The igniter assembly does not require any adjustments beyond making sure the springs and the burner electrode rods make solid contact when the igniter is in the closed position. The sealing surfaces of the gaskets should be checked and replaced at the first signs of any damage or deterioration. Clean any dirt or residue from the porcelain bushings, springs, and baseplate.

The simplest way to check igniter operation is by supplying voltage to the input and checking to see whether an arc is produced. Check by either looking or listening to see if there is an arc across the electrodes while the burner is running and the igniter is energized.

The igniter must be grounded to the burner before checking the following. To check the igniter, insure that the burner is off, and use an ohmmeter to check the resistance between one of the springs and exposed metal on the burner (for example, a housing bolt). The meter should read less than 2000 ohms when measuring the spring-to-ground resistance at either spring.

The igniter should be replaced if the meter indicates an open circuit, the difference between the two spring-to-ground resistance readings is greater than 20%, or the spring-to-spring resistance does not read approximately twice the spring-to-ground reading.

Figure 4 – Igniter hinge and retainer clips



### E. Servicing nozzle line assembly

Before proceeding, turn off power to the burner.

1. Disconnect the oil connector tube from the nozzle line.
2. Referring to Figure 4, loosen the two screws securing the igniter retaining clips and rotate both clips to release the igniter baseplate. Then tilt the igniter back on its hinge.
3. Remove the splined nut.
4. Remove the nozzle line assembly from the burner, being careful not to damage the electrodes or insulators while handling. To ease removal of long assemblies (over 9 inches), rotate the assembly 180° from the installed position after pulling partially out of the tube.
5. To replace the nozzle line assembly, reverse the above steps.

### F. Check/adjust "Z" dimension

Refer to Figure 5. The critical "Z" dimension is the distance from the face of the nozzle to the flat face of the head. This distance for F heads is  $1 \frac{1}{8}$ ". The "Z" dimension is factory set for burners shipped with the air tube installed but should always be verified during service and installation. If the "Z" dimension is out of adjustment, perform the following steps.

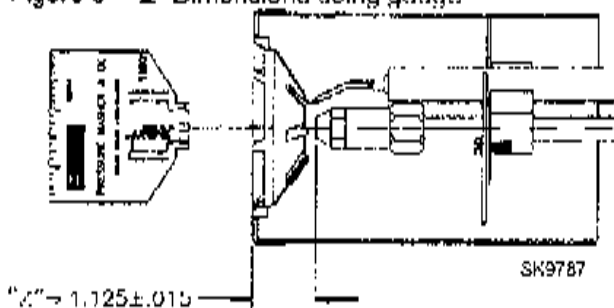
Before proceeding, turn off power to the burner.

1. Disconnect the oil connector tube from the nozzle line.
2. Referring to Figure 3, loosen the splined nut from the nozzle line. Loosen the hex head screw securing the escutcheon plate to the burner housing.
3. A Beckett T650 gauge should be used to set the Z-dimension. Place the end of a ruler at the face of the nozzle and, using a straight edge across the head, measure the distance to the face of the head.
4. Slide the nozzle line forward or back until this dimension for F heads is  $1 \frac{1}{8}$ ".
5. Tighten the hex head screw to secure the escutcheon plate to the burner chassis. Then tighten the splined nut and attach the oil connector tube.
6. Recheck the "Z" dimension periodically when servicing to ensure the escutcheon plate has not shifted. You will need to reset the "Z" dimension if you replace the air tube or nozzle line assembly.

#### NOTICE

The Beckett Z gauge (part number Z-2000) is available to permit checking the F head "Z" dimension without removing the burner.

Figure 5 – Z- Dimensions using gauge





### 4 Fuel Supply Maintenance

#### A. Connect fuel lines

For oil supply system specifications for tanks not mounted on machines, carefully follow the pump manufacturer's literature and the latest edition of NFPA 31. If this information is unavailable, use the following basic guidelines:

#### NOTICE

Pumps with automatic bypass do not require a bypass plug.

#### WARNING

The burner pump is shipped without the bypass plug installed. You must install this plug on two-pipe oil systems. If the unit is a one-pipe oil system DO NOT install the plug in the pump. Failure to comply could cause pump seal failure, oil leakage and the potential for a fire and injury hazard.

#### B. Fuel supply level with or above burner

The burner may be equipped with a single-stage pump. If a one pipe system is installed, insure that a bypass plug is not installed in the pump, then connect the fuel supply to the burner with a single supply line. Note that manual bleeding of the pump is required on initial start-up. When connecting a two-pipe fuel supply, install the pump bypass plug.

#### WARNING

The oil supply inlet pressure to the pump cannot exceed 3 psi. Install a pressure-limiting device in accordance with NFPA 31.

#### C. Fuel supply below level of burner

When the fuel supply is located below the level of the burner, a two-pipe fuel supply system is not necessary, but depending on the fuel line diameter and horizontal and vertical length, the installation may also require a two-stage pump. Consult the pump manufacturer's literature for lift and vacuum capability.

#### D. Fuel line replacement (remote tank only)

When replacing fuel lines, continuous lengths of heavy wall copper tubing is recommended. To ensure a tight seal, always use flare fittings. Never use compression fittings.

Always install fittings in an accessible location. To avoid vibration noise, fuel lines should not run against the appliance or the ceiling joists.

#### WARNING

Never use Teflon tape on any fuel fitting. Tape fragments can lodge in fuel line components and the fuel pump, damaging the pump and preventing proper operation.

#### E. Fuel line valve and filter

Shutoff valves should be located in the oil supply line, never the return line.

### 5. Burner Maintenance & Wiring

#### A. Burner Installed on Washer

Refer to appliance manufacturer's wiring diagram for electrical connections. Refer to Appendix A for burner maintenance procedures.

#### B. Burner Replacement

Burner wiring may vary, depending on the actual primary control and furnished options. Refer to Figure B for typical burner wiring, showing CAD coil primary controls. Note that the relay and control, shown in the wiring diagram are optional features.

All wiring must be in accordance with the latest revision of National Electric Code NFPA 70 and all local codes and regulations.

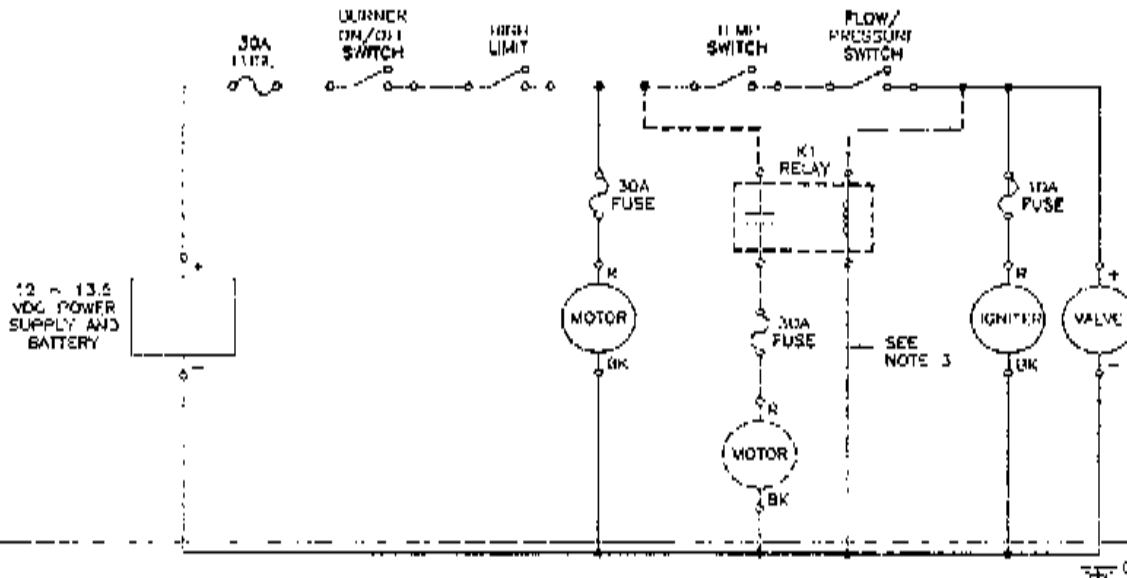
#### NOTICE

The wiring diagrams in this manual are for general reference only. Refer to the equipment manufacturer's literature or the diagrams supplied with the equipment. Failure to install correct wiring could result in severe personal injury, death or substantial property damage.

**WARNING**

Electrical shock hazard. Disconnect power before servicing.

Figure 6A -- Recommended Field Wiring

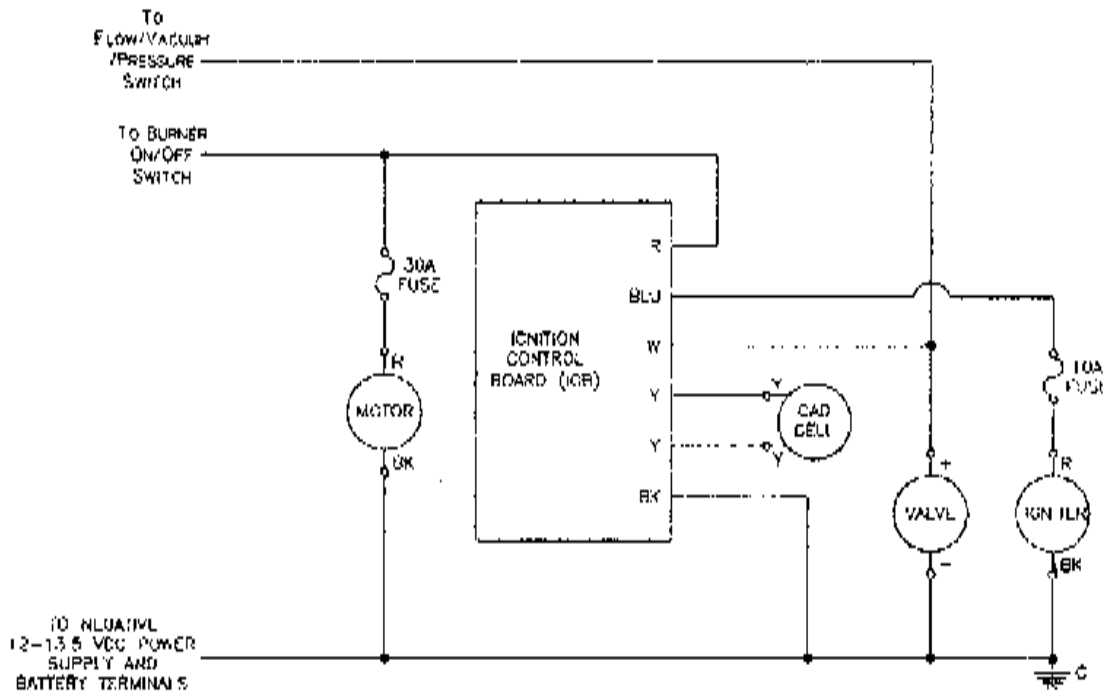


NOTES:

1. All wires are to be 14 GA. Minimum (18 GA. for valve & igniter) to prevent voltage drop between battery and burner.
2. Motor runs continuously in normal configuration.
3. Optional motor configuration shown in dashed lines cycles motor with trigger. K1 relay to be S.P.S.T. N.O. contacts with 25 A minimum current rating. (100 amp in-rush) @ 12 volts DC.

SK9789

Figure 6B -- Wiring with ICB

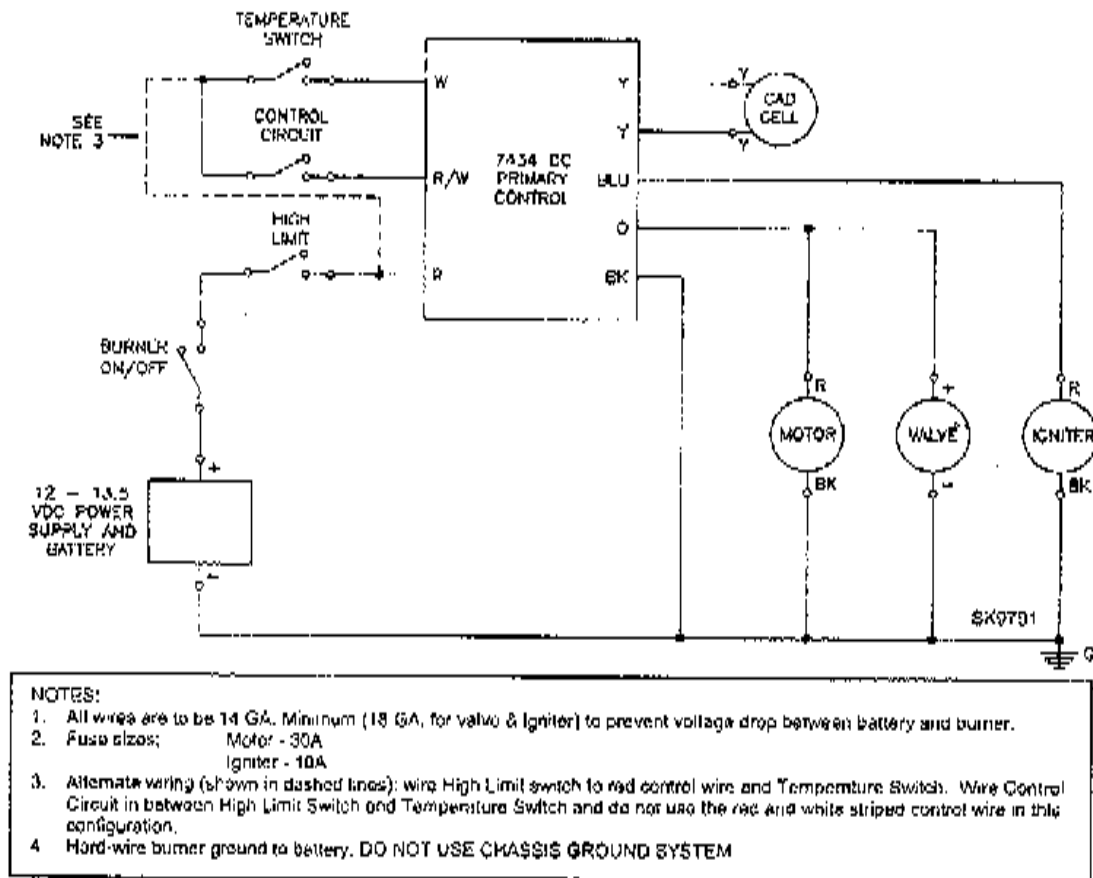


NOTES:

1. All wires are to be 14 GA. Minimum (18 GA. for valve & igniter) to prevent voltage drop between battery and burner.
2. Alternate wiring: white wire of ICB may be wired to red wire of ICB, and positive valve wire may be wired to flow or pressure switch.
3. Hard-wire burner ground to battery. DO NOT USE CHASSIS GROUND SYSTEM.

SK9790

Figure 6C – Wiring with 7434 Control



## 6. Drive component maintenance

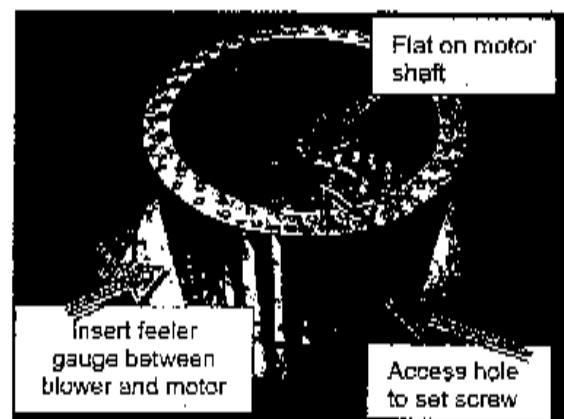
### A. Motor, blower wheel, and coupling replacement

The motor will require replacement if the proper voltage is measured at the motor input, and the motor will either not run, or the current draw with a free running pump exceeds 10% of the rated current.

To replace the burner motor, coupling and/or blower wheel perform the following steps.

1. Before servicing, turn off and/or disconnect all power to the burner.
2. Disconnect the burner motor wires.
3. Remove the bolts securing the motor to the burner housing.
4. Remove the motor, coupling, and blower wheel.
5. Loosen the set screw on the blower wheel to slide the existing wheel off the shaft.
6. Slide the new blower wheel onto the old shaft (after thoroughly cleaning housing) and/or slide the old blower wheel onto the new motor shaft.
7. Place a .030" ( $\frac{1}{32}$ "  $\pm$   $\frac{1}{64}$ ") feeler gauge between the blower wheel and the motor housing.
8. Slide the blower wheel toward the motor until it contacts the feeler gauge.
9. Rotate the blower wheel until the setscrew is centered on the flat of the motor shaft. Tighten the setscrew to secure the wheel.

Figure 7. – Blower Wheel



10. Slide the motor coupling on the motor shaft then install the motor on the burner housing. Insure that the motor coupling fits between the motor shaft and the pump shaft inside the housing. Tighten the motor retaining screws. Reconnect the wires.
11. Restore power, start the burner and perform the combustion test described previously in this manual.

## Instruction Manual – Model ADC Oil Burner

### B. Pump Maintenance

#### CAUTION

This Equipment must be installed, adjusted and started only by a qualified service technician - an individual or agency, licensed and experienced with all codes and ordinances, who is responsible for the installation and adjustment of the equipment. The installation must comply with all local codes and ordinances and with the National Fire Protection Association Standard for Liquid Fuel Equipment, NFPA 31 (or CSA B139).

#### General pump information

Important information - Long or oversized inlet lines may require the pump to operate dry during initial bleeding period. In such cases, the priming may be assisted by injecting fuel oil in the pump gear set. Under lift conditions, lines and fittings must be air tight. To assure this, 'Pipe Dope' may be applied to both the used and unused inlet and return fittings.

#### CAUTION

Do NOT use Teflon tape! Do NOT use compression fittings!

**Mounting Position** - Beckett CleanCut pump may be mounted in any position (except upside-down during single pipe installation).

**Vacuum check** - A Vacuum Gage may be installed in either of the 1/4" NPT inlet ports.

**Pressure check** - When a pressure check is made use the nozzle port. If the bleed port is used, the reading on the gauge should be approximately 5 psig higher than the pressure reading on the nozzle port.

**Cutoff check** - To check cutoff pressure dead head a pressure gage in the nozzle port. Run the burner for a short period of time. Shut the burner off. The pressure will drop and hold above zero.

#### CAUTION

Pressurized or gravity feed installations must not exceed 3 psi on inlet line or return line at the pump per NFPA 31. A pressure greater than 10 psi may cause damage to the shaft seal.

#### Mounting the pump

To install a CleanCut pump on a pre 2002 burner chassis with an existing shutter tab follow the instructions included with the pump.

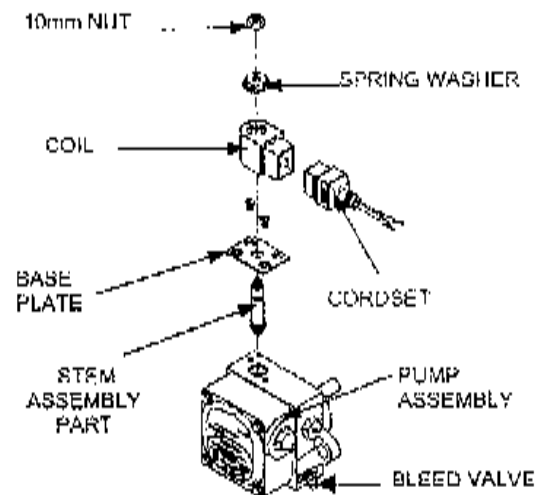
### C. Valve Coil and Stem Replacement

To determine if the valve coil requires replacement perform the following steps.

1. Remove the cord set from the valve.
2. Place the leads from an ohmmeter across the coil

3. A 12 volt coil should measure between 15 and 25 ohms.
4. If the meter indicates an open circuit, replace the coil.

Figure 8. – Pump and Valve assemblies



To check pump operation perform the following.

1. Check the operating pressure by removing the copper tubing from the nozzle line and installing a pressure gauge in the line. With the motor running and the coil energized, check the gauge. The pressure should read 100 psig unless otherwise stated.
2. To check the cutoff function, deadhead the pressure gauge onto the copper connector tube attached to the nozzle port. Run the burner for a short period of time. Shut the burner off; the pressure should drop and hold.

To replace the coil and/or valve stem assembly perform the following steps.

1. Before servicing, turn off and/or disconnect all power to the burner.
2. Use the shut-off valve between the fuel tank and the pump to block oil from the burner.
3. Remove the copper Tube Assembly when replacing the pump or when removing the coil and the tube blocks the coil.
4. Using a flat tip screwdriver, press the flat tip into the spring washer to prevent it from rotating.
5. Using a 10mm wrench or adjustable wrench, remove the nut and spring washer.
6. Remove the coil by lifting it straight up.
7. Remove the two base plate screws, then the base plate by lifting straight up.
8. Remove valve stem assembly by pulling straight up.
9. To install the new stem and coil assemblies, follow the above steps in reverse order, tightening each part as you go.
10. Restore power, start the burner and perform the combustion test described previously in this manual.

## 7. Start up burner & Set combustion

### A. Basic burner operation

On the Beckett ADC Oil burner standard configuration, the motor and igniter operate continuously while the valve, that controls oil flow, is cycled by the switches on the power washer. The motor is used to drive the blower and pump. The rotational speed of the motor is determined by the voltage supplied and the load placed on the motor. Pump pressure and air settings are the main factors affecting the motor load. The igniter converts battery DC voltage into a high voltage spark to ignite the oil. The igniter is capable of running continuously as long as the blower wheel is circulating air across the igniter base. The pump and solenoid valve are used to control the flow of oil from the reservoir to the nozzle. The pump pressurizes the oil. When energized, the valve enables high pressure oil flow to the nozzle. An optional control circuit can also be supplied to reduce current draw on the charging system by turning the igniter off after a flame has been established. This option controls igniter operation based on a signal from a light sensing CAD cell. When light hits the cell the control will sense a decrease in resistance across the sensor. A few seconds delay will occur prior to the igniter switching off. As long as sufficient light is reaching the cell eye, the igniter will remain off. If light is removed from the sensor, the igniter will turn on until light is again sensed by the CAD cell.

Variations to the burner circuits may occur due to optional temperature, pressure, and vacuum switches that control burner operation. Note that when external switches are used to control the motor operation they must be sized correctly for the rated current or a relay should be installed to isolate the switches from the motor's full load current.

### B. Combustion set-up

#### WARNING

Do not attempt to start the burner if excess fuel or vapor has accumulated in the equipment. Starting the burner under these conditions could result in a puffback of hot combustion gases, high smoke levels, or hazardous operation.

Open all shutoff valves located in the oil supply line to the burner.

As soon as burner motor starts rotating bleed all the air from the pump. (Required with single-pipe systems)

To bleed the pump, attach a clear plastic hose over the vent fitting. Loosen the fitting and catch the oil in an empty container. Tighten the fitting when all air has been purged from the supply system. **Note:** If the burner stops after a flame is established, the unit probably requires additional bleeding. Continue to bleed the system until the pump is primed and a flame is established when the vent fitting is closed.

### C. Set combustion with instruments

#### WARNING

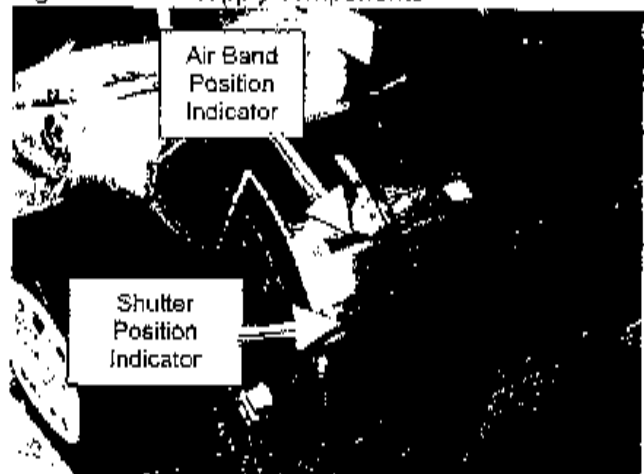
The combustion level should be adjusted using dedicated combustion test equipment. Failure to properly set the burner could result in inefficient operation, and/or conditions that could potentially cause severe personal injury, death or substantial property damage.

#### NOTICE

Combustion testing instruments can be purchased from most HVAC suppliers. If your usage does not warrant purchasing the equipment, contact a reputable HVAC contractor to perform a combustion test and adjustment.

1. Allow the burner to run for approximately 5 to 10 minutes.

Figure 9. – Air supply components



2. Follow these three steps to properly adjust the burner:
  - Step 1: Use a smoke tester to check for a clean flame. If necessary, adjust the air shutter and air band to obtain a trace to one smoke. See Figure 2.
  - Step 2: With the smoke level at a trace to one, measure the CO<sub>2</sub> (or O<sub>2</sub>). This will be the reference point for further adjustments.
  - Step 3: Increase the air to reduce smoke levels to zero or a trace. Recheck the CO<sub>2</sub> (or O<sub>2</sub>). It should be lower than the initial reading.
3. Once the combustion level is set, tighten the fasteners on the air band and air shutter.
4. Start and stop the burner several times to ensure satisfactory operation.
5. Test the equipment safety controls to verify that they function according to the manufacturer's specifications.

## Appendix A, Maintain & Service Burner

### A. Owner's information

#### **WARNING**

Have your equipment inspected at regular intervals by a qualified service agency to assure continued proper operation. The burner should be adjusted using dedicated combustion test equipment. Failure to properly set the burner could result in inefficient operation, and/or conditions that could potentially cause severe personal injury, death or substantial property damage.

The following could result in fire hazard, severe personal injury, death or substantial property damage. Read carefully.

- Never attempt to use gasoline in your burner.
- Never store gasoline or combustible materials near the burner.
- Never attempt to light the burner by throwing burning material into the fire chamber.
- Never attempt to use crankcase or waste oil or material other than the approved fuel oils in this burner.
- Never restrict the air inlet openings to the burner or the combustion air ventilation openings in the room.

### B. Owner service and maintenance

Properly installed and maintained, your ADC burner will provide years of efficient, trouble-free operation. Please take care of your equipment by following the warnings provided and by doing the following (notify your qualified service agency if your burner is not operating properly):

#### **WARNING**

This equipment should be serviced only by a qualified service agency. The appropriate test instruments must be used. Failure to do so could result in burner or equipment failure, could potentially cause severe personal injury, death or substantial property damage.

### C. Daily

Check the area around your burner/equipment to make sure:

- air ventilation openings are clean and unobstructed
- nothing is blocking the burner inlet air openings
- no combustible materials are stored near the equipment
- there are no signs of oil or water leakage around the burner or equipment

### D. Extended down time

If the equipment will be stored for an extended period of time, insure that the fuel tank is full and add a fuel stabilizer to the tank.

### E. Regular Service/Maintenance

Have your burner, power washer, crack sealer, etc. serviced annually by your qualified service agency.

The following components/assemblies should be checked/adjusted/replaced on a regular basis. Refer to the Replacement Parts exploded view for part locations.

- Replace the oil supply line filter if applicable. The line filter cartridge must be replaced to avoid contamination of the pump and nozzle.
- Inspect the oil supply system. All fittings should be leak-tight. The supply lines should be free of water, sludge and other restrictions.
- Remove and clean the pump strainer.
- Replace the nozzle with one having the same specifications from the same manufacturer.
- Clean and inspect the electrodes for damage, replacing any that are cracked or chipped.
- Check electrode tip settings. Replace electrodes if tips are rounded.
- Inspect the igniter spring contacts. Clean or replace if corroded.
- Clean the cad cell, if applicable.
- Make sure Low Firing Rate Baffle is in place if required for the burner application. Omitting the baffle can result in unacceptable burner combustion.
- Inspect all gaskets including the igniter base plate gasket. Replace any that are damaged or missing.
- Clean the blower wheel, air inlet, air guide, retention head and static plate of any dirt, asphalt or other material
- Check motor current. The amp draw should not exceed the nameplate rating by more than 10%.
- Check all wiring for loose connections or damaged insulation.
- Check the pump pressure and cutoff function.
- Check primary control safety lockout timing if applicable. Refer to the information supplied by the control manufacturer for procedures.
- Check ignition system for proper operation.
- Inspect the exhaust system for soot accumulation or other restriction.
- Clean the equipment thoroughly according to the manufacturer's recommendations.
- Check the burner performance. Refer to Section 3.
- It is good practice to make a record of the service performed and the combustion test results.

### Appendix B. Burner Troubleshooting

Oil burners that are designed for use in pressure washers are built to take temperature extremes, vibration and rough handling. When performing the following troubleshooting steps, we assume that the oil burner motor and ignition transformer operate continuously and the oil solenoid valve, which controls oil flow, is cycled by the trigger on the wand. We also assume that there is power to the burner, and fuel in the tank.

In addition to normal mechanic's tools, it is recommended to have the following equipment on hand: An electrical meter capable of measuring volts, ohms, and amps, an ignition transformer tester, a smoke pump tester, combustion analyzer and a zero to 200 psi oil pressure gauge.

#### Troubleshooting Chart

Symptom	Possible cause:	Additional info/Procedure
Oil not igniting	<p>If the burner is not igniting, the burner motor, drive coupling, and oil pump are operating and oil is flowing to the nozzle through the solenoid valve, check the following possibilities.</p> <ol style="list-style-type: none"> <li>1) Check the air shutter adjustment. If the air shutter is opened too far, the flow of air may prevent the igniter from reaching the oil spray. This may appear as a white vapor exhaust from the coil.</li> <li>2) The ignition system may have failed to supply an adequate arc to ignite the oil. Check the battery and charging system to insure a continuous supply of 11 to 16 volts DC (15 amps)</li> <li>3) Check the electrodes for wear and damage. Insure that the electrodes are adjusted properly.</li> </ol>	<ol style="list-style-type: none"> <li>1) Refer to Section 7, C.</li> <li>2) Refer to Section 2.</li> <li>3) Refer to Section 3, C.</li> </ol>
No Flame	<p>If there is no flame, the burner motor and ignition transformer operate continuously and the oil solenoid valve, which controls oil flow, is cycled by the trigger in the wand, check the following possibilities.</p> <ol style="list-style-type: none"> <li>1) Check for a plugged oil nozzle.</li> <li>2) If the coil on the solenoid valve is actuating, insure that the valve is opening</li> <li>3) Check for sufficient fuel pressure. Pressure is 100psig unless otherwise noted.</li> <li>4) Check the pump pressure. Check for air in fuel lines.</li> <li>5) Check burner for broken motor coupling. If the coupling is broken check pump rotation prior to replacing the coupling.</li> <li>6) Check for contaminated fuel and/or partially plugged fuel filter.</li> </ol>	<ol style="list-style-type: none"> <li>1) Refer to Section 3, A.</li> <li>2) Refer to Section 6, C.</li> <li>3) Refer to Section 6, B.</li> <li>4) Refer to Section 6, B.</li> <li>5) Refer to Section 6, A.</li> <li>6) Refer to Section 4, E.</li> </ol>
Motor not operating	<p>If the blower motor is not operating, check the following possibilities.</p> <ol style="list-style-type: none"> <li>1) Check voltage at the motor to insure that switches and relays, in line with the motor, are operating properly.</li> <li>2) Check pump and motor shaft operation. They should work freely without binding.</li> <li>3) Check the fuse and/or breaker on the motor.</li> </ol>	<ol style="list-style-type: none"> <li>1) Refer to Section 2.</li> <li>2) Refer to Section 6, B.</li> <li>3) Refer to Section 6.</li> </ol>
No oil spray	<p>If the blower motor is operating, there is fuel in the reservoir, but oil does not spray out the end of the nozzle, check the following possibilities.</p> <ol style="list-style-type: none"> <li>1) Check for a broken or stripped coupling between the pump and the motor.</li> <li>2) Check the pump output for oil.</li> <li>3) Check operation of the oil valve.</li> <li>4) Check for a plugged nozzle</li> <li>5) Check for air in the oil line</li> <li>6) Check for fuel contamination or plugged filter</li> </ol>	<ol style="list-style-type: none"> <li>1) Refer to Section 6, A.</li> <li>2) Refer to Section 6, B.</li> <li>3) Refer to Section 6, B.</li> <li>4) Refer to Section 3, A.</li> </ol>

## Instruction Manual – Model ADC Oil Burner

<b>Fluctuating or no pump pressure</b>	If the pump pressure, as determined by a pressure gauge, is erratic or does not exist, check the following possibilities: <ol style="list-style-type: none"><li>1) Check motor rotational speed. Low rpm's can cause erratic or no pump pressure.</li><li>2) Check for a broken or worn motor coupling</li><li>3) Check that the pump turns freely</li><li>4) Check for air leaks in the lines</li><li>5) Check for oil froth within the reservoir</li><li>6) Check voltage at the motor</li><li>7) Check for fuel contamination or partially plugged filter</li></ol>	<ol style="list-style-type: none"><li>1) Refer to Section 6, A.</li><li>2) Refer to Section 6, B.</li><li>3) Refer to Section 6, B.</li> <li>4) Refer to voltage rating on Nameplate.</li></ol>
<b>Slow motor rotation</b>	If the blower motor is not operating at the rpm's listed on the nameplate, check the following: <ol style="list-style-type: none"><li>1) Check the supply voltage to the motor.</li><li>2) Check for free operation of the motor shaft and pump assembly.</li></ol>	<ol style="list-style-type: none"><li>1) Refer to voltage rating on Nameplate.</li><li>2) Refer to Section 6, A &amp; B.</li></ol>



## Appendix C. Replacement Parts

For best performance specify genuine **Beckett** replacement parts

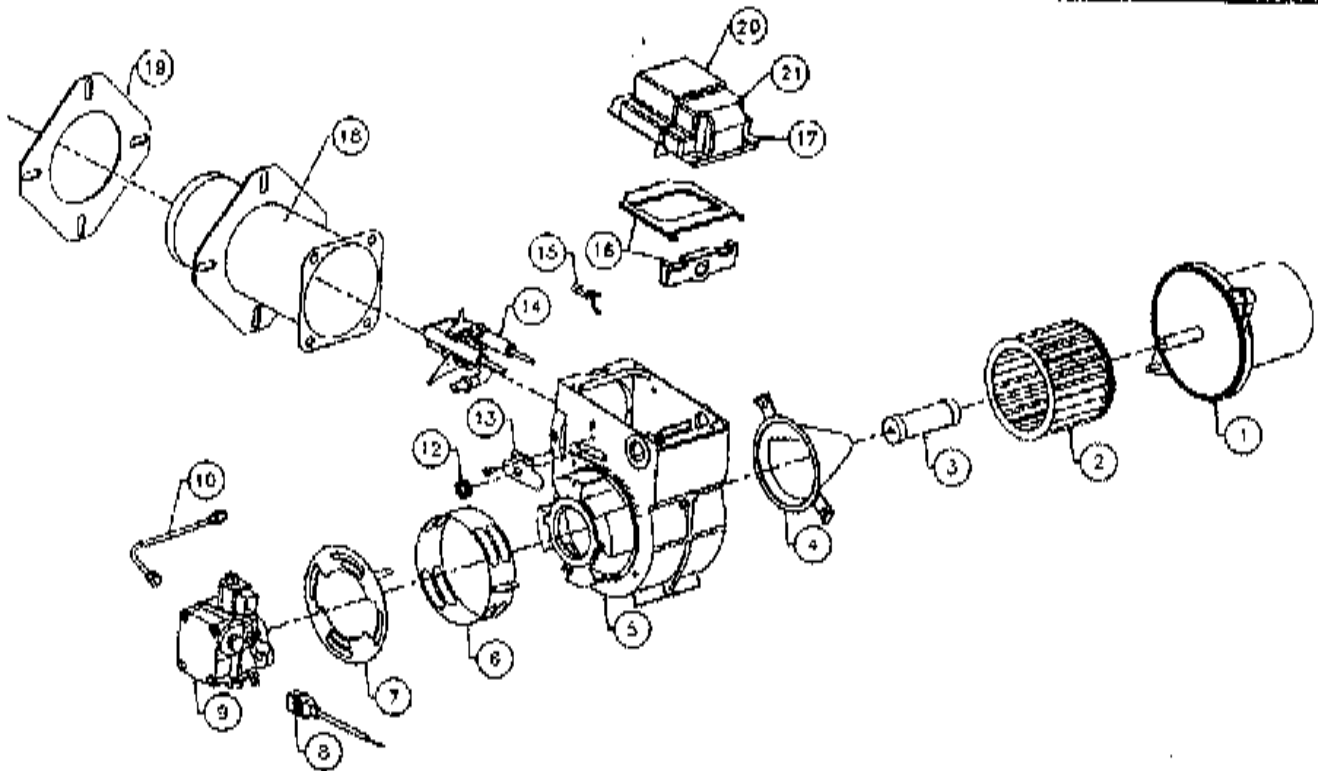


Illustration #	Description	Part#
1	DC Motor	21699UF
2	Blower Wheel	2140401
3	Coupling	21405
4	Air Guide	31231U
5	Burner Housing - Black- Gray-	5874BKU 5877
6	Air Band	5151501
7	Air Shutter 4 Slot Air Shutter 8 Slot	3709 3494
8	Cord set	21807
9	Pump (CleanCut)	218440ZU
10	Tube assembly	21877U

Illustration #	Description	Part#
11	12 volt Coil	21754U
12	Escutcheon plate spline nut	3666
13	Escutcheon plate	3493
14	Electrode kit	5700
15	Cad cell detector	74927006
16	Igniter gasket kit	51411
17	Igniter w/ICB Igniter w/o ICB	51776U 51777U
18	Air tube assemblies	Specify
19	Flange mounting gasket	
20	Ignitor only	7435U
21	Ignitor Control Board	51663

Limited  
**WARRANTY**

For Residential, Commercial and Specialty Burners

THE R. W. BECKETT CORPORATION ("Beckett") warrants to persons who purchase its Beckett burners from Beckett for resale or for incorporation into a product for resale ("Customer") that no equipment is free from defects in material and workmanship under normal use and service for 60 months from the date of manufacture for Residential Burners and 18 months from the date of manufacture for Commercial and Specialty Burners. Residential burner models include: AF, APG, AFH, NX, SF, SR and SMG. Commercial burner models include: CF375, CF500, CF800, CF1400, CF2100A, CF2500, CF3500A, CG10, CG15, CG75 and CG99. Specialty burner models include: ADC, ADCP, ARV, SDC and SM. The provisions of this warranty are provided in individual major burner components as follows:

- a) 60 months from date of manufacture for all Beckett-branded major components, except for 12 Vdc components.
- b) 18 months from date of manufacture for all non-Beckett-branded major components and Beckett branded 12 Vdc components.

Note: Normal service items found to be defective upon receipt by the customer are covered by this warranty.

THIS WARRANTY DOES NOT EXTEND TO EQUIPMENT SUBJECTED TO ABUSE, NEGLIGENCE, OR ACCIDENT; NOR DOES THIS WARRANTY APPLY UNLESS THE PRODUCT COVERED BY IT IS PROPERLY INSTALLED BY A QUALIFIED COMPETENT TECHNICIAN, WHO IS LICENSED WHERE STATE AND LOCAL CODES REQUIRE, AND WHO IS EXPERIENCED IN MAKING SUCH INSTALLATIONS, IN ACCORDANCE WITH THE LATEST EDITION OF APPENDIX D OF THE NATIONAL FIRE PROTECTION ASSOCIATION; THE LATEST EDITION OF THE NATIONAL FUEL GAS CODE (NFPA NO. 54) AND IN ACCORDANCE WITH ALL APPLICABLE LOCAL, STATE AND NATIONAL CODES HAVING JURISDICTIONAL AUTHORITY.

Equipment, which is defective in material or workmanship and within the warranty period, may be returned for credit as follows:

Beckett Burners, Beckett-branded major components and non-Beckett-branded major components that came as original equipment on a Beckett burner or were sold as a replacement part by Beckett should be returned, freight prepaid, to Beckett's home office. Credit will be issued to the customer unless the returned equipment is determined by Beckett to be out of warranty or damaged by user, in which case the equipment will be scrapped.

Note: Beckett is not responsible for any labor cost for removal and replacement of equipment.

THIS WARRANTY IS LIMITED TO THE PRECISE TERMS SET FORTH ABOVE, AND PROVIDES EXCLUSIVE REMEDIES EXPRESSLY IN LIEU OF ALL OTHER REMEDIES, AND IN PARTICULAR THERE SHALL BE EXCLUDED THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT WILL BECKETT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGE OF ANY NATURE. Beckett neither warrants nor authorizes any person to assume for Beckett any other liability or obligation in connection with the sale of this equipment. Beckett's liability and Customer's exclusive remedy being limited to credit as set forth above.

**R.W. BECKETT CORPORATION**

P.O. Box 1269 Elyria, Ohio 44036

Form No. 6104BAIX R806

**R.W. BECKETT CORPORATION**

U.S.A.: P.O. Box 1269 • Elyria, Ohio 44036

Canada: R.W. Beckett Canada, Ltd. • Unit #3, 430 Laird Road • Guelph, Ontario N1G 3X7

Form Number 6104BAIX R806

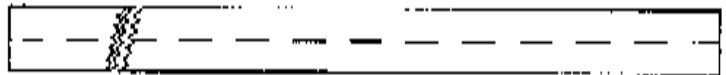


6104BAIX



0 45558 00957 0

# Crack Pro



TherWorks Industries, Inc.  
Sandusky, Ohio  
(419) 626 4375

## BURNER REPLACEMENT PARTS

REF.#	ITEM	PART #	QTY
1	Motor	P662A012	1
2	Blower wheel	P662A013	1
3	Coupling	P662A016	1
4	Air guide	P662A022	1
9	Pump	P662A011	1
10	Tube assembly	P662A019	1
11	Oil valve	P662A020	1
14	Electrode kit	P662A018	1
15	Cad cell	P662A014	1
17	Igniter	P662A015	1
21	Igniter control board ( primary )	P662A010	1
NS	Nozzle (specify size)	P662A017	1
	Complete burner	P662A009	1

PO Box 2277, Sandusky, OH 44870, (419) 626-4375 FAX (419) 626-5477

# OPERATOR'S MANUAL

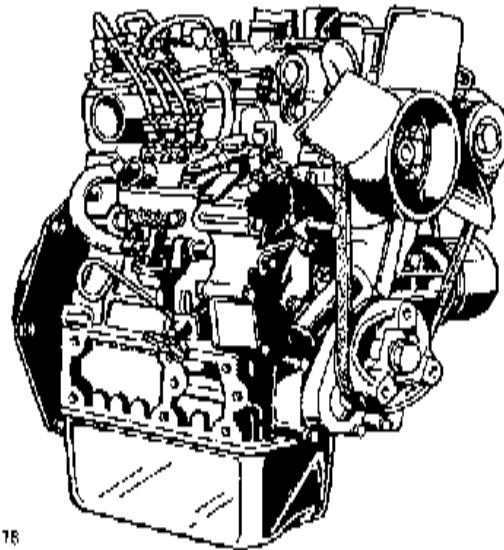
ENGLISH

# KUBOTA DIESEL ENGINE

Crack Pro 125 2602

Crack Pro 200/400 D902

MODELS Z482-E·Z602-E  
D662-E·D722-E  
D782-E·D902-E



D 147R

READ AND SAVE THIS BOOK

Kubota

# CONTENTS

<b>▲ SAFE OPERATION</b> .....	1
SERVICING OF THE ENGINE .....	1
NAMES OF PARTS .....	2
PRE-OPERATION CHECK .....	3
BREAK-IN .....	3
DAILY CHECK .....	3
OPERATING THE ENGINE .....	4
STARTING THE ENGINE(NORMAL) .....	4
COLD WEATHER STARTING .....	5
STOPPING THE ENGINE .....	6
CHECKS DURING OPERATION .....	6
Radiator Cooling water(Coolant) .....	6
Oil pressure lamp .....	6
Fuel .....	7
Color of exhaust .....	7
Immediately stop the engine if; .....	7
REVERSED ENGINE REVOLUTION AND REMEDIES .....	7
How to tell when the engine starts running backwards .....	7
Remedies .....	7
MAINTENANCE .....	8
SERVICE INTERVALS .....	9
PERIODIC SERVICE .....	11
FUEL .....	11
Fuel level check and refueling .....	11
Air bleeding the fuel system .....	11
Checking the fuel pipes .....	12
Cleaning the fuel filter pot .....	12
ENGINE OIL .....	13
Checking level and adding engine oil .....	13
Changing engine oil .....	14
Replacing the oil filter cartridge .....	15
RADIATOR .....	15
Checking coolant level, adding coolant .....	15
Changing coolant .....	17
Checking radiator hoses and clamp .....	17
Precaution at overheating .....	17
Anti-freeze .....	17
Radiator cement .....	18
AIR CLEANER .....	18
For the air cleaner with a dust cup (optional) .....	19
BATTERY .....	19
Battery charging .....	19
Direction for long term storage .....	20
ELECTRIC WIRING .....	20

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FAN BELT .....	21
Adjusting Fan Belt Tension.....	21
CARRIAGE AND STORAGE.....	22
CARRIAGE .....	22
STORAGE.....	22
TROUBLESHOOTING.....	23
SPECIFICATIONS .....	25
WIRING DIAGRAMS .....	26

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# FOREWORD

You are now the proud owner of a KUBOTA Engine. This engine is a product of KUBOTA quality engineering and manufacturing. It is made of fine materials and under a rigid quality control system. It will give you long, satisfactory service. To obtain the best use of your engine, please read this manual carefully. It will help you become familiar with the operation of the engine and contains many helpful hints about engine maintenance. It is KUBOTA's policy to utilize as quickly as possible every advance in our research. The immediate use of new techniques in the manufacture of products may cause some small parts of this manual to be outdated. KUBOTA distributors and dealers will have the most up-to-date information. Please do not hesitate to consult with them.



## SAFETY FIRST

This symbol, the industry's "Safety Alert Symbol", is used throughout this manual and on labels on the machine itself to warn of the possibility of personal injury. Read these instructions carefully. It is essential that you read the instructions and safety regulations before you attempt to assemble or use this unit.



**DANGER :** Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.



**WARNING :** Indicates a potentially hazardous situation which, if not avoided, COULD result in death or serious injury.



**CAUTION:** Indicates a potentially hazardous situation which, if not avoided, MAY result in minor or moderate injury.

**IMPORTANT :** Indicates that equipment or property damage could result if instructions are not followed.

**NOTE :** Gives helpful information.



# SAFE OPERATION

Careful operation is your best insurance against an accident. Read and understand this section carefully before operating the engine. All operators, no matter how much experience they may have had, should read this and other related manuals before operating the engine or any equipment attached to it. It is the owner's obligation to instruct all operators in safe operation.

Be sure to observe the following for safe operation.

## 1. OBSERVE SAFETY INSTRUCTIONS

- Read and understand carefully this "OPERATOR'S MANUAL" and "LABELS ON THE ENGINE" before attempting to start and operate the engine.
- Learn how to operate and work safely. Know your equipments and its limitations. Always keep the engine in good condition.
- Before allowing other people to use your engine, explain how to operate and have them read this manual before operation.
- DO NOT modify the engine by yourself. UNAUTHORIZED MODIFICATIONS to the engine may impair the function and/or safety and affect engine life.



1AAACAAAP008B

## 2. WEAR SAFETY CLOTHING

- DO NOT wear loose, torn or bulky clothing around the machine that may catch on working controls and projections causing personal injury.
- Use additional safety items, e.g. hard hat, safety protection, gloves, etc., as appropriate or required.
- DO NOT operate machine or any equipment attached to it while under alcohol, medication, or other drugs, or while fatigued.
- DO NOT wear radio or music headphones while operating engine.



1ACAAAAAP0130



## 2 SAFE OPERATION

## 3. CHECK BEFORE OPERATION &amp; STARTING THE ENGINE

- Be sure to check the engine before operation. If something is wrong with the engine, do not fail to repair it quickly.
- Keep all guards and shields in place before operating the engine. Replace any that are damaged or missing.
- Check to see if there is a safe distance from the engine before starting.
- Always keep the engine at least 3 feet (1 meter) away from buildings and other facilities.
- DO NOT allow children or livestock to approach the machine while the engine is running.
- DO NOT start the engine by shorting across starter terminals. The machine may start in gear and move.



1BAABADAP0010

## 4. KEEP AROUND THE ENGINE CLEAN

- Be sure to stop the engine before cleaning.
- Keep the engine clean and free of accumulated dirt, grease and trash to avoid a fire. Store flammable fluids away from sparks and fire.
- DO NOT stop the engine without idling; Temperatures around the engine rise suddenly. Keep the engine idling for over about 5 minutes before stopping.



1AEAAAAP0120

## 5. SAFE HANDLING OF FUEL AND LUBRICANTS -KEEP OFF FIRE-

- Always stop the engine before refueling or/and lubricating.
- DO NOT smoke or allow flames or sparks in your working area. Fuel is extremely flammable and explosive under certain conditions.
- Refuel at a well ventilated and open place. When fuel and lubricants are spilled, refuel after letting engine cool off.
- DO NOT mix gasoline or alcohol with diesel fuel. The mixture can cause a fire.



1AAACAAP001A

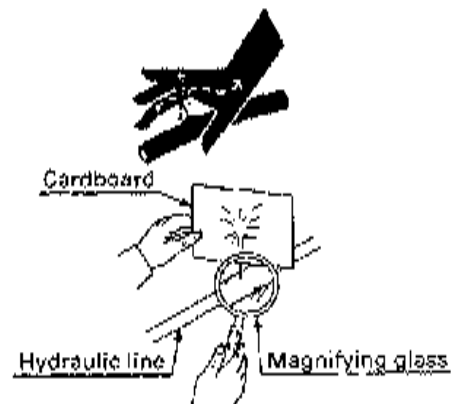
## 6. EXHAUST GASES & FIRE PREVENTION

- Engine exhaust fumes can be very harmful if allowed to accumulate. Be sure to run the engine in a well ventilated place and where there are no people or livestock near the engine.
- The exhaust gas from the muffler is very hot. To prevent a fire, do not expose dry grass, mowed grass, oil and any other combustible materials to exhaust gas. Also, keep the engine and muffler clean all the time.
- To avoid a fire, be alert for leaks of flammables from hoses and lines. Be sure to check for leaks from hoses or pipes, such as fuel and hydraulic by following the maintenance check list.
- To avoid a fire, do not short across power cables and wires. Check to see that all power cables and wirings are in good condition. Keep all power connections clean. Bare wire or frayed insulation can cause a dangerous electrical shock and personal injury.



## 7. ESCAPING FLUID

- Relieve all pressure in the air, the oil and the cooling systems before any lines, fittings or related items are removed or disconnected.
- Be alert for possible pressure when disconnecting any device from a system that utilizes pressure. DO NOT check for pressure leaks with your hand. High pressure oil or fuel can cause personal injury.
- Escaping hydraulic fluid under pressure has sufficient force to penetrate skin causing serious personal injury.
- Fluid escaping from pinholes may be invisible. Use a piece of cardboard or wood to search for suspected leaks: do not use hands and body. Use safety goggles or other eye protection when checking for leaks.
- If injured by escaping fluid, see a medical doctor immediately. This fluid can produce gangrene or severe allergic reaction.



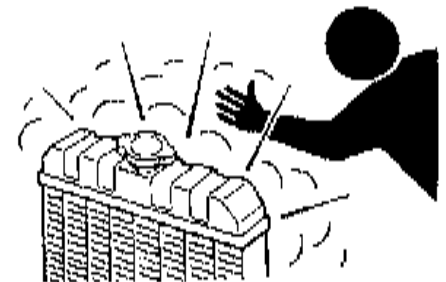
1AB4AAAAP1200

## 8. CAUTIONS AGAINST BURNS & BATTERY EXPLOSION

- To avoid burns, be alert for hot components, e.g. muffler, muffler cover, radiator, pipings, engine body, coolants, engine oil, etc. during operation and just after the engine has been shut off.
- DO NOT remove the radiator cap while the engine is running or immediately after stopping. Otherwise hot water will spout out from radiator. Wait for more than ten minutes to cool the radiator, before removing the cap.
- Make sure to shut the drain valve of coolant and oil to close pressure cap, to fasten pipe band before operating. If those parts are taken off, or loosen, it will result in serious personal injury.
- The battery presents an explosive hazard. When the battery is being activated, hydrogen and oxygen gases are extremely explosive.
- DO NOT use or charge the battery if its fluid level stands below the LOWER mark  
Otherwise, the component parts may deteriorate earlier than expected, which may shorten the service life or cause an explosion. Immediately, add distilled water until the fluid level is between the UPPER and LOWER levels.
- Keep sparks and open flames away from the battery, especially when charging the battery. DO NOT strike a match near the battery.
- DO NOT check battery charge by placing a metal object across the terminals. Use a voltmeter or hydrometer.
- DO NOT charge battery if frozen. It can be explosive. When frozen, warm the battery up more than 16° C (61° F).



1AFARAAAP0080



1AARAAABAP0230



1ARAEAAAP0520

## 9. HANDS AND BODY AWAY FROM THE ROTATING PARTS

- Be sure to stop the engine before checking or adjusting belt tension and cooling fan.
- Keep your hands and body away from the rotating parts, such as cooling fan, V-belt, fan drive V-belt, pulley or flywheel causing personal injury.
- DO NOT run the engine with installed safety guards detached. Install safety guards securely during operation.



1ARAAAAAP1470

## 10. ANTI-FREEZE & DISPOSAL OF FLUIDS

- Anti-freeze contains poison. Wear rubber gloves to avoid personal injury. In case of contact with skin, wash it off immediately.
- DO NOT mix different types of Anti-freeze. The mixture can produce chemical reaction causing harmful substances. Use approved or genuine KUBOTA Anti-freeze.
- Be mindful of the environment and the ecology. Before draining any fluids, find out the correct way of disposing of them. Observe the relevant environmental protection regulations when disposing of oil, fuel, coolant, brake fluid, filters and batteries.
- When draining fluids from the engine, place some container underneath the engine body.
- DO NOT pour waste onto the grounds, down a drain, or into any water source.



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1BJA3AAAP0180

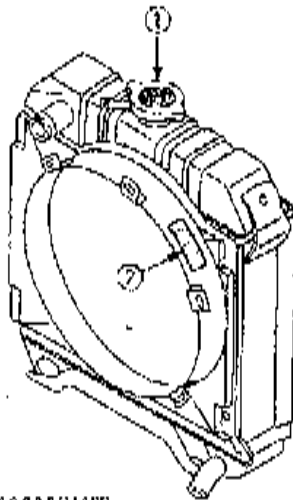
## 11. CONDUCTING SAFETY CHECKS & MAINTENANCE

- When checking engine or servicing, place the engine on a wide and level ground. DO NOT work on anything that is supported ONLY by lift jacks or a hoist. Always use blocks or correct stands to support the engine before servicing.
- Detach the battery from the engine before conducting service. Put a "DO NOT OPERATE!" tag in the key switch to avoid accidental starting.
- To avoid sparks from an accidental short circuit always disconnect the battery's ground cable (-) first and connect it last.
- Be sure to stop the engine and remove the key when conducting daily and periodic maintenance, servicing and cleaning.
- Check or conduct maintenance after the engine, coolant, muffler, or muffler cover have been cooled off completely.
- Always use the appropriate tools and jig-fixture in good condition when performing any service work. Make sure you understand how to use them before service.
- Use ONLY correct engine barring techniques for manually rotating the engine. DO NOT attempt to rotate the engine by pulling or prying on the cooling fan and V-belt. This practise can cause serious personal injury or premature machine damage to the cooling fan.
- Replace fuel pipes and lubricant pipes with their hose clamps every 2 years or earlier whether they are damaged or not. They are made of rubber and are aged gradually.
- When servicing is performed together by two or more persons, take care to perform all work safely.
- Keep first aid kit and fire extinguisher handy at all times.



1BJABAAAP0200

## 12. WARNING AND CAUTION LABELS



1A8AAAAAP1400

- ① Part No.19077-8724-1 or 16667-8724-1  
(55mm in diameter) (37mm in diameter)



1A8AAAAAP1490

- ② Part No.TA040-4957-1  
Stay clear of engine  
fan and fan belt



1A8AAAAAP1500

## 13. CARE OF WARNING AND CAUTION LABELS

1. Keep warning and caution labels clean and free from obstructing material.
2. Clean warning and caution labels with soap and water, dry with a soft cloth.
3. Replace damaged or missing warning and caution labels with new labels from your local KUBOTA dealer.
4. If a component with warning and caution label(s) affixed is replaced with new part, make sure new label(s) is (are) attached in the same location(s) as the replaced component.
5. Mount new warning and caution labels by applying on a clean dry surface and pressing any bubbles to outside edge.

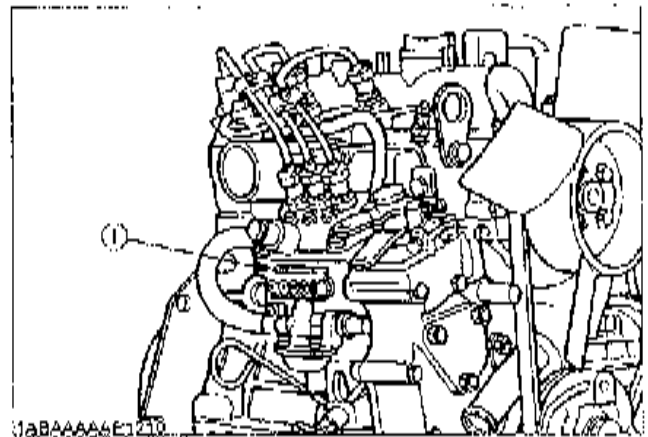
# SERVICING OF THE ENGINE

Your dealer is interested in your new engine and has the desire to help you get the most value from it. After reading this manual thoroughly, you will find that you can do some of the regular maintenance yourself.

However, when in need of parts or major service, be sure to see your KUBOTA dealer.

For service, contact the KUBOTA Dealership from which you purchased your engine or your local KUBOTA dealer. When in need of parts, be prepared to give your dealer the engine serial number.

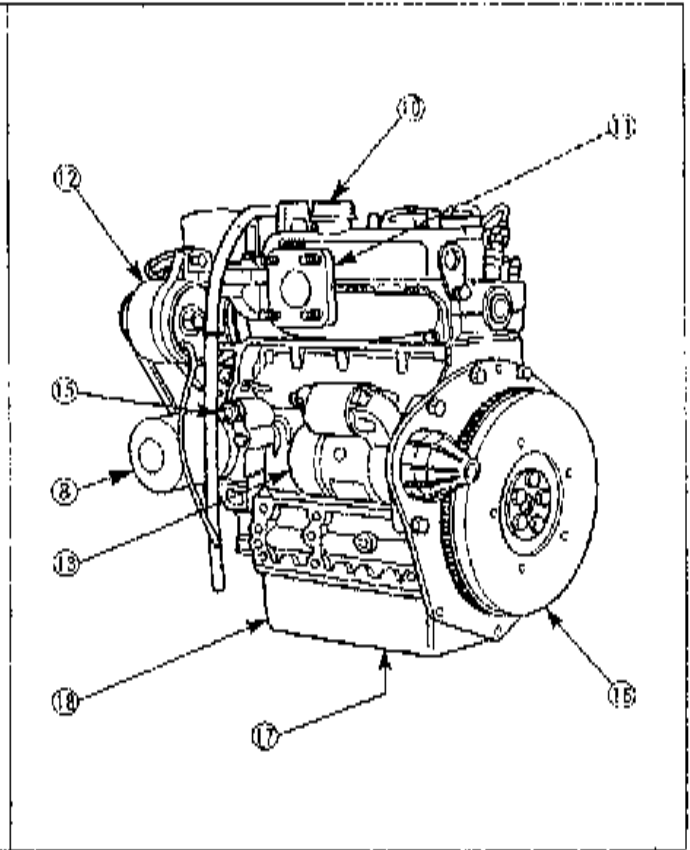
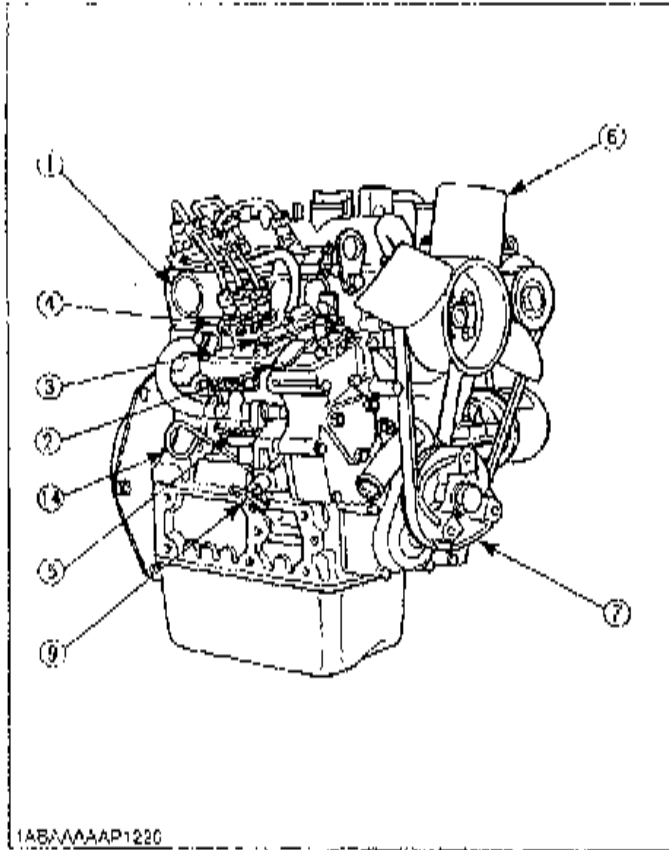
Locate the serial number now and record them in the space provided.



(1) Engine serial number

	Type	Serial No.
Engine		
Date of Purchase		
Name of Dealer		
(To be filled in by purchaser)		

# NAMES OF PARTS



1AB/AAAAP1226

- (1) Intake manifold
- (2) Speed control lever
- (3) Engine stop lever
- (4) Injection pump
- (5) Fuel feed pump
- (6) Cooling fan
- (7) Fan drive pulley
- (8) Oil filter cartridge
- (9) Water drain cock

- (10) Oil filter plug
- (11) Exhaust manifold
- (12) Alternator
- (13) Starter
- (14) Oil level gauge
- (15) Oil pressure switch
- (16) Flywheel
- (17) Oil drain plug
- (18) Oil pan

# PRE-OPERATION CHECK

## BREAK-IN

During the engine break-in period, observe the following by all means:

1. Change engine oil and oil filter cartridge after the first 50 hours of operation (See "ENGINE OIL" in Periodic Service Section).
2. When ambient temperature is low, operate the machine after the engine has been completely warmed up.

## DAILY CHECK

To prevent trouble from occurring, it is important to know the conditions of the engine well. Check it before starting.



### CAUTION

To avoid personal injury:

- Be sure to install shields and safeguards attached to the engine when operating.
- Stop the engine at a flat and wide space when checking.
- Keep dust or fuel away from the battery, wiring, muffler and engine to prevent a fire. Check and clear them before operating everyday. Pay attention to the heat of the exhaust pipe or exhaust gas so that it can not ignite trash.

Item		Ref. page
1. Parts which had trouble in previous operation		-
2. By walking around the machine	(1) Oil or water leaks	13 to 15
	(2) Engine oil level and contamination	13
	(3) Amount of fuel	11
	(4) Amount of coolant	15
	(5) Dust in air cleaner dust cup	19
	(6) Damaged parts and loosened bolts and nuts	-
3. By inserting the key into the starter switch	(1) Proper functions of meters and pilot lamps; no stains on these parts	-
	(2) Proper function of glow lamp timer	-
4. By starting the engine	(1) Color of exhaust fumes	7
	(2) Unusual engine noise	7



# OPERATING THE ENGINE

## STARTING THE ENGINE(NORMAL)



### CAUTION

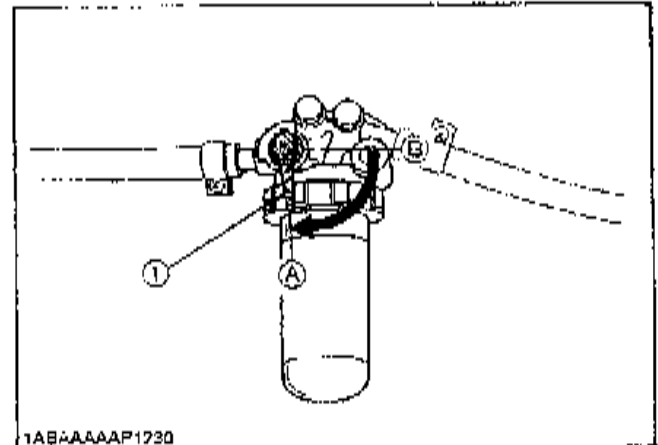
To avoid personal injury:

- Do not allow children to approach the machine while the engine is running.
- Be sure to install the machine on which the engine is installed, on a flat place.
- Do not run the engine on gradients.
- Do not run the engine in an enclosed area. Exhaust gas can cause air pollution and exhaust gas poisoning.
- Keep your hands away from rotating parts (such as fan, pulley, belt, flywheel etc.) during operation.
- Do not operate the machine while under the influence of alcohol or drugs.
- Do not wear loose, torn or bulky clothing around the machine. It may catch on moving parts or controls, leading to the risk of accident. Use additional safety items, e.g. hard hat, safety boots or shoes, eye and hearing protection, gloves, etc., as appropriate or required.
- Do not wear radio or music headphones while operating engine.
- Check to see if it is safe around the engine before starting.
- Reinstall safeguards and shields securely and clear all maintenance tools when starting the engine after maintenance.

### IMPORTANT :

- Do not use ether or any starting fluid for starting the engine, or a severe damage will occur.
- When starting the engine after a long storage (of more than 3 months), first set the stop lever to the "STOP" position and then activate the starter for about 10 seconds to allow oil to reach every engine part.

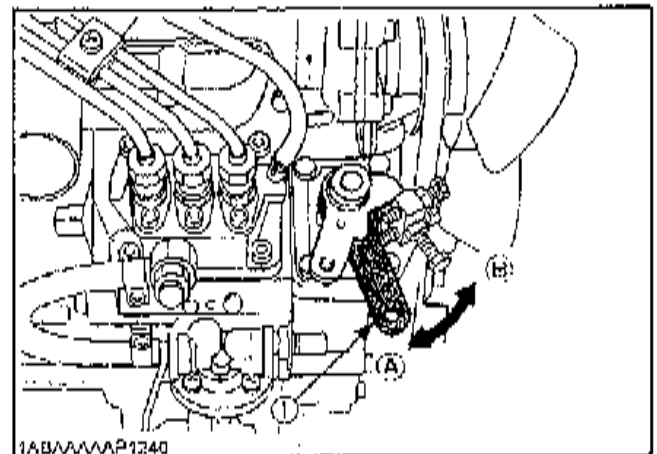
1. Set the fuel lever to "ON".



(1) Fuel lever

(A) "ON"  
(B) "OFF"

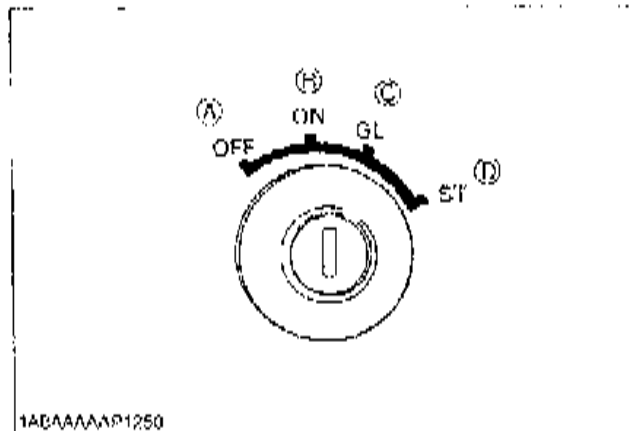
2. Place the engine stop lever in the "START" position.
3. Place the speed control lever at more than half "OPERATION"



(1) Speed Control lever

(A) "OPERATION"  
(B) "IDLING"

- Insert the key into the key switch and turn it "ON".



1ABAAAAAP1250

- (A) "OFF" (SWITCHED OFF)  
 (B) "ON" (OPERATION)  
 (C) "PREHEAT"  
 (D) "START"

- Turn the starter switch to the "PREHEAT" position to allow the glow lamp to redden.
- Turn the key to the "START" position and the engine should start. Release the key immediately when the engine starts.
- Check to see that the oil pressure lamp and charge lamp are off. If the lamps are still on, immediately stop the engine, and determine the cause.

(See "CHECKS DURING OPERATION" in Operating the Engine Section)

**NOTE:**

- If the oil pressure lamp should be still on, immediately stop the engine and check:
  - if there is enough engine oil,
  - if the engine oil has dirt in it,
  - if the wiring is faulty.

- Warm up the engine at medium speed without load.

**IMPORTANT:**

- If the glow lamp should redden too quickly or too slowly, immediately ask your KUBOTA dealer to check and repair it.
- If the engine does not catch or start at 10 seconds after the starter switch is set at "START" position, wait for another 30 seconds and then begin the engine starting sequence again. Do not allow the starter motor to run continuously for more than 20 seconds.

**COLD WEATHER STARTING**

If the ambient temperature is below\*  $-6^{\circ}\text{C}$  ( $23^{\circ}\text{F}$ ) and the engine is very cold, start it in the following manner: Take steps (1) through (4) left.

- Turn the key to the "PREHEAT(GLOW)" position and keep it there for a certain period mentioned below.

**IMPORTANT:**

- Shown below are the standard preheating times for various temperatures. This operation, however, is not required, when the engine is warmed up.

Ambient temperature	Preheating time	
	Ordinary heat type	With glow lamp timer
Above $10^{\circ}\text{C}$ ( $50^{\circ}\text{F}$ )	NO NEED	
$10^{\circ}\text{C}$ ( $50^{\circ}\text{F}$ ) to $-5^{\circ}\text{C}$ ( $23^{\circ}\text{F}$ )	Approx. 5 seconds	See NOTE:
*Below $-5^{\circ}\text{C}$ ( $23^{\circ}\text{F}$ )	Approx. 10 seconds	
Limit of continuous use	20 seconds	

**NOTE:**

- In case of installing standard glow lamp, glow lamp goes off after about 6 seconds, when the starter switch key is turned to preheat position. However if necessary, keep the starter switch key at the "PREHEAT" position for longer time, according to the left recommendation.

- Turn the key to the "START" position and the engine should start.

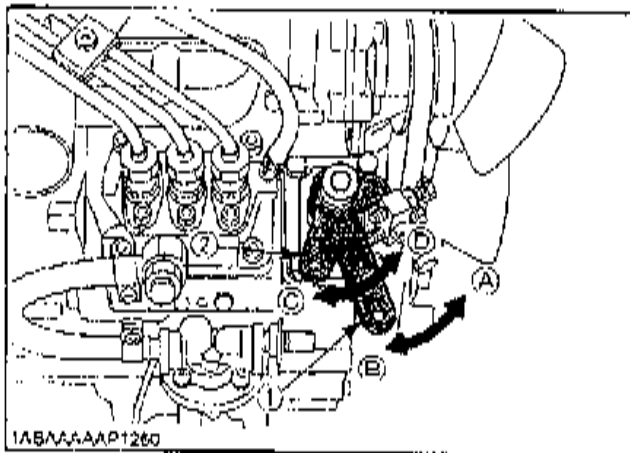
(If the engine fails to start after 10 seconds, turn off the key for 5 to 30 seconds. Then repeat steps (5) and (6).)

**IMPORTANT:**

- Do not allow the starter motor to run continuously for more than 20 seconds.
- Be sure to warm up the engine, not only in winter, but also in warmer seasons. An insufficiently warmed-up engine can shorten its service life.
- When there is fear of temperature dropping below  $-15^{\circ}\text{C}$  ( $5^{\circ}\text{F}$ ) detach the battery from the machine, and keep it indoors in a safe area, to be reinstalled just before the next operation.

## STOPPING THE ENGINE

1. Return the speed control lever to low idle, and run the engine under idling
2. Set the engine stop lever to "STOP" position.
3. With the starter switch placed at "OFF" position, remove the key. (Be sure to return the stop lever as it was after stopping the engine, and get ready for the next starting.)



- |                         |                 |
|-------------------------|-----------------|
| (1) Speed control lever | (A) "IDLING"    |
| (2) Engine stop lever   | (B) "OPERATION" |
|                         | (C) "START"     |
|                         | (D) "STOP"      |

## CHECKS DURING OPERATION

While running, make the following checks to see that all parts work well.

### ■ Radiator Cooling water (Coolant)



#### WARNING

To avoid personal injury:

- Do not remove radiator cap until coolant temperature is well below its boiling point. Then loosen cap slightly to the stop position, to relieve any pressure, before removing cap completely.

When the engine overheats and hot coolant overflows through the radiator and hoses, stop the engine immediately and make the following checks to determine the cause of trouble:

#### Check item

1. Check to see if there is any water leak;
2. Check to see if there is any obstacle around the cooling air inlet or outlet;
3. Check to see if there is any dirt or dust between radiator fin and tube;
4. Check to see if the fan belt is too loose;
5. Check to see if radiator water pipe is clogged;
6. Check to see if anti-freeze is mixed into coolant in warm seasons.

### ■ Oil pressure lamp

The lamp lights up to warn the operator that the engine oil pressure has dropped below the prescribed level. If this should happen during operation or should not go off even after the engine is accelerated more than 1000rpm, immediately stop the engine and check the following:

1. Engine oil level (See "ENGINE OIL" in Maintenance Section).
2. Lubricant system (See "ENGINE OIL" in Maintenance Section).

## ■ Fuel



### CAUTION

To avoid personal injury:

- Fluid escaping from pinholes may be invisible. Do not use hands to search for suspected leaks; Use a piece of cardboard or wood, instead. If injured by escaping fluid, see a medical doctor at once. This fluid can produce gangrene or a severe allergic reaction.
- Check any leaks from fuel pipes or fuel injection pipes. Use eye protection when checking for leaks.

Be careful not to empty the fuel tank. Otherwise air may enter the fuel system, requiring fuel system bleeding. (See "FUEL" in Maintenance Section).

## ■ Color of exhaust

While the engine is run within the rated output range:

- The color of exhaust remains colorless.
- If the output slightly exceeds the rated level, exhaust may become a little colored with the output level kept constant.
- If the engine is run continuously with dark exhaust emission, it may lead to trouble.

## ■ Immediately stop the engine if;

- The engine suddenly slow down or accelerates.
- Unusual noises suddenly appear.
- Exhaust fumes suddenly become very dark.
- The oil pressure lamp or the water temperature alarm lamp lights up.

## REVERSED ENGINE REVOLUTION AND REMEDIES



### CAUTION

To avoid personal injury:

- Reversed engine operation can make the machine reverse and run it backwards. It may lead to serious trouble.
- Reversed engine operation may make exhaust gas gush out into the intake side and ignite the air cleaner; It could catch fire.

Reversed engine revolution must be stopped immediately since engine oil circulation is cut quickly, leading to serious trouble.

## ■ How to tell when the engine starts running backwards

1. Lubricating oil pressure drops sharply. Oil pressure warning light, if used, will light.
2. Since the intake and exhaust sides are reversed, the sound of the engine changes, and exhaust gas will come out of the air cleaner.
3. A louder knocking sound will be heard when the engine starts running backwards.

## ■ Remedies

1. Immediately set the engine stop lever to "STOP" position to stop the engine.
2. After stopping the engine, check the air cleaner, intake rubber tube and other parts and replace parts as needed.

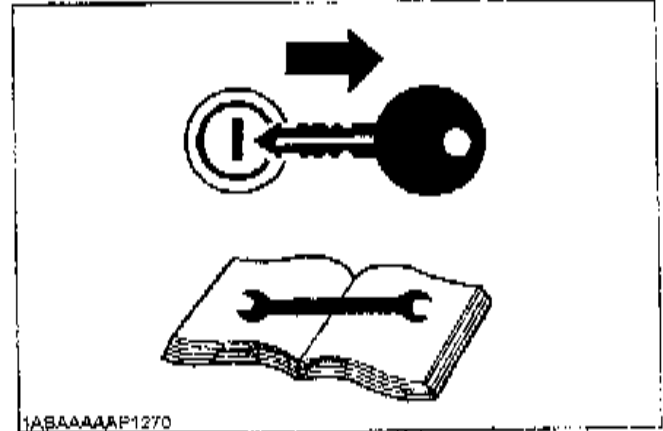
# MAINTENANCE



## CAUTION

To avoid personal injury:

- Be sure to conduct daily checks, periodic maintenance, refueling or cleaning on a level surface with the engine shut off and remove the key.
- Before allowing other people to use your engine, explain how to operate, and have them read this manual before operation.
- When cleaning any parts, do not use gasoline but use regular cleanser.
- Always use proper tools, that are in good condition. Make sure you understand how to use them, before performing any service work.
- When installing, be sure to tighten all bolts lest they should be loose. Tighten the bolts by the specified torque.
- Do not put any tools on the battery, or battery terminals may short out. Severe burns or fire could result. Detach the battery from the engine before maintenance.
- Do not touch muffler or exhaust pipes while they are hot; Severe burns could result.



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## SERVICE INTERVALS

Observe the following for service and maintenance.

The lubricating oil change intervals listed in the table below are for Classes CF, CE and CD lubricating oils of API classification with a low sulfur fuel in use. If the CF-4 or CG-4 lubricating oil is used with a high-sulfur fuel, change the lubricating oil at shorter intervals than recommended in the table below depending on the operating condition.

Interval	Item	Ref. page		
Every 50 hours	Check of fuel pipes and clamp bands	12		@
See NOTE	Change of engine oil (depending on the oil pan)	13,14	①	
Every 100 hours	Cleaning of air cleaner element	18,19	*1	①
	Cleaning of fuel filter	12		
	Check of battery electrolyte level	19,20		
	Check of fan belt tightness	21		
Every 200 hours	Check of radiator hoses and clamp bands	17		
	Replacement of oil filter cartridge (depending on the oil pan)	15	②	
	Check of intake air line	-		③
Every 400 hours	Replacement of fuel filter element	12		@
Every 600 hours	Removal of sediment in fuel tank	-		
	Cleaning of water jacket (radiator interior)	-		
	Replacement of fan belt	21		
Every one or two months	Recharging of battery	19,20		
Every year or every 6 cleanings of air cleaner element	Replacement of air cleaner element	18,19	*2	@
Every 800 hours	Check of valve clearance	23		
Every 1500 hours	Check of fuel injection nozzle injection pressure	-	*3	@
Every 3000 hours	Check of turbo charger	-	*3	@
	Check of injection pump	-	*3	@
	Check of fuel injection timer	-	*3	@
Every two years	Replacement of battery	19,20		
	Replacement of radiator hoses and clamp bands	17		
	Replacement of fuel pipes and clamps	12	*3	@
	Change of radiator coolant (L.L.C.)	15		
	Replacement of intake air line	-	*4	@

### IMPORTANT -

- The jobs indicated by ① must be done after the first 50 hours of operation.
- \*1 Air cleaner should be cleaned more often in dusty conditions than in normal conditions.
- \*2 After 6 times of cleaning.
- \*3 Consult your local KUBOTA Dealer for this service.
- \*4 Replace only if necessary.
- The items listed above (@ marked) are registered as emission related critical parts by KUBOTA in the U.S. EPA nonroad emission regulation. As the engine owner, you are responsible for the performance of the required maintenance on the engine according to the above instruction. Please see the Warranty Statement in detail.

**NOTE:**

- Changing interval of engine oil and oil filter cartridge.

		*Oil pan depth	
		101 mm (3.98 in.)	121 mm (4.76 in.)
Z602-E D902-E	Engine oil	50 Hrs (Initial)	
		100 Hrs	
	Oil filter cartridge	200 Hrs	
Z482-E D662-E D722-E	Engine oil	50 Hrs (Initial)	
		75 Hrs	100 Hrs
	Oil filter cartridge	150 Hrs	200 Hrs
D782-E	Engine oil	-	50 Hrs (Initial)
			100 Hrs
			200 Hrs
	Oil filter cartridge	200 Hrs	

\* 101 mm (3.98 in.) oil pan depth is optional for Z482-E, D662-E, D722-E.

\*\*Standard replacement interval

- API service classification: above CD grade
- Ambient temperature: below 35° C (95° F)

● **Lubricating oil**

With the emission control now in effect, the CF-4 and CG-4 lubricating oils have been developed for use of a low-sulfur fuel on on-road vehicle engines. When an off-road vehicle engine runs on a high-sulfur fuel, it is advisable to employ the CF, CD or CE lubricating oil with a high total base number. If the CF-4 or CG-4 lubricating oil is used with a high-sulfur fuel, change the lubricating oil at shorter intervals.

- **Lubricating oil recommended when a low-sulfur or high-sulfur fuel is employed.**

○ : Recommendable X : Not recommendable

Lubricating oil class	Fuel		Remarks
	Low-sulfur	High-sulfur	
CF	○	○	TBN ≥ 10
CF-4	○	X	
CG-4	○	X	

# PERIODIC SERVICE

## FUEL

Fuel is flammable and can be dangerous. You should handle fuel with care.



### CAUTION

To avoid personal injury:

- Do not mix gasoline or alcohol with diesel fuel. This mixture can cause an explosion.
- Be careful not to spill fuel during refueling. If fuel should spill, wipe it off at once, or it may cause a fire.
- Do not fail to stop the engine before refueling. Keep the engine away from the fire.
- Be sure to stop the engine while refueling or bleeding and when cleaning or changing fuel filter or fuel pipes. Do not smoke when working around the battery or when refueling.
- Check the above fuel systems at a well ventilated and wide place.
- When fuel and lubricant are spilled, refuel after letting the engine cool off.
- Always keep spilled fuel and lubricant away from engine.

### ■ Fuel level check and refueling

1. Check to see that the fuel level is above the lower limit of the fuel level gauge.
2. If the fuel is too low, add fuel to the upper limit. Do not overfill.

No.2-D is a distillate fuel oil of lower volatility for engines in industrial and heavy mobile service.

(SAE J313 JUN87)

Grade of Diesel Fuel Oil According to ASTM D975

Flash Point, °C (°F)	Water and Sediment, volume %	Carbon Residue on, 10 percent Residuum, %	Ash, weight %
Min	Max	Max	Max
52 (125)	0.05	0.35	0.01

Distillation Temperatures, °C(°F) 90% Point		Viscosity Kinematic cSt or mm <sup>2</sup> /s at 40°C		Viscosity Saybolt, SUS at 37.8°C(100°F)	
Min	Max	Min	Max	Min	Max
287 (540)	338 (640)	1.9	4.1	32.6	40.1
Sulfur, weight %		Copper Strip Corrosion		Cetane Number	
Max		Max		Min	
0.40		No. 3		40	

The cetane number is required not less than 45.

### IMPORTANT :

- Be sure to use a strainer when filling the fuel tank, or dirt or sand in the fuel may cause trouble in the fuel injection pump.
- For fuel, always use diesel fuel. You are required not to use alternative fuel, because its quality is unknown or it may be inferior in quality. Kerosene, which is very low in octane rating, adversely affects the engine. Diesel fuel differs in grades depending on the temperature.
- Be careful not to let the fuel tank become empty, or air can enter the fuel system, necessitating bleeding before next engine start.

### ■ Air bleeding the fuel system



### CAUTION

To avoid personal injury:

- Do not bleed a hot engine as this could cause fuel to spill onto a hot exhaust manifold creating a danger of fire.

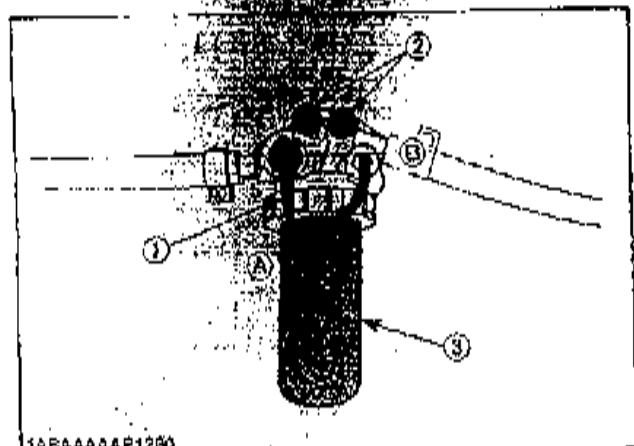
Air bleeding of the fuel system is required if;

- after the fuel filter and pipes have been detached and refilled;
- after the fuel tank has become empty; or
- before the engine is to be used after a long storage.



**[PROCEDURE]**

1. Fill the fuel tank to the top and bleed the fuel filter lever.
2. Loosen air vent plug and bleed a few turns.
3. Screw back the plug until it does not come up any more.
4. Open the air vent and bleed the fuel injection pump.
5. Retighten the plug until it does not come up any more.



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- |                       |           |
|-----------------------|-----------|
| (1) Fuel filter lever | (A) "ON"  |
| (2) Air vent plug     | (B) "OFF" |
| (3) Fuel filter pot   |           |

**■Checking the fuel pipes**



**CAUTION**

To avoid personal injury:

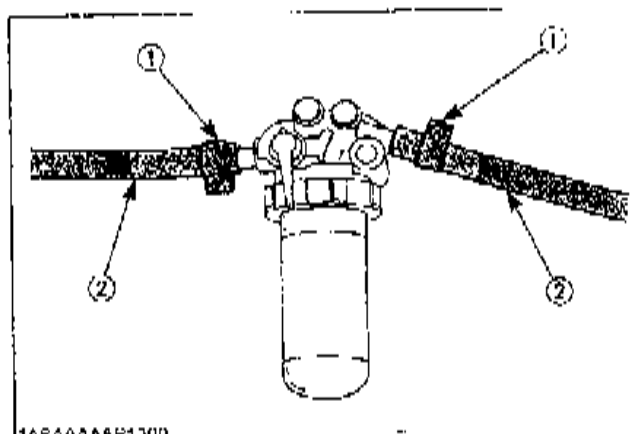
- Check or replace the fuel pipes after stopping the engine. Broken fuel pipes can cause fires.

Check the fuel pipes every 50 hours of operation. When if:

1. If the clamp band is loose, apply oil to the screw of the band, and tighten the band securely.
2. If the fuel pipes, made of rubber, became worn out, replace them and clamp bands every two years.
3. If the fuel pipes and clamp bands are found worn or damaged before two years' time, replace or repair them at once.
4. After replacement of the pipes and bands, air-bleed the fuel system.

**IMPORTANT :**

- When the fuel pipes are not installed, plug them at both ends with clean cloth or paper to prevent dirt from entering. Dirt in the pipes can cause fuel injection pump malfunction.



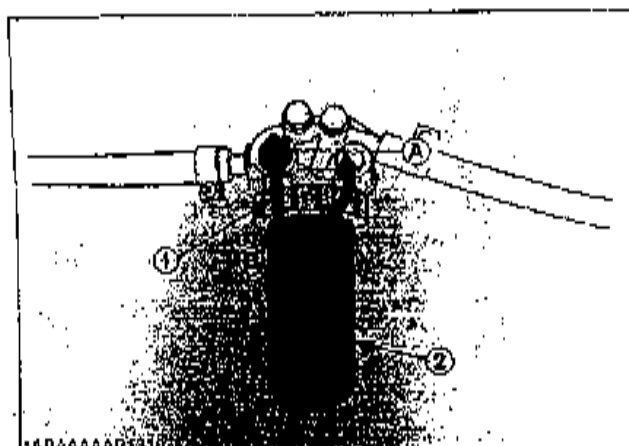
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- |                |
|----------------|
| (1) Clamp band |
| (2) Fuel pipe  |

**■Cleaning the fuel filter pot**

Every 100 hours of operation, clean the fuel filter in a clean place to prevent dust intrusion

1. Close the fuel filter lever.



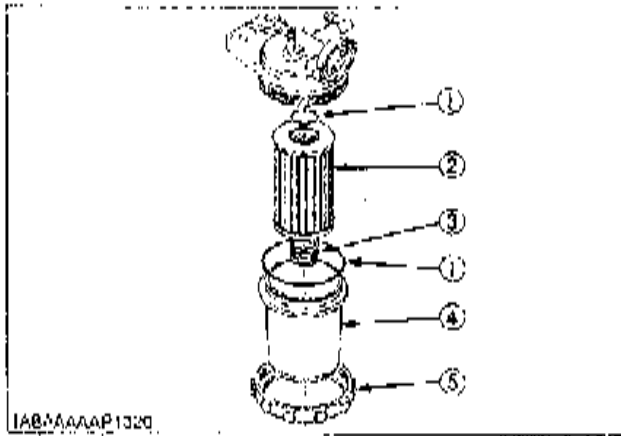
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- |                       |           |
|-----------------------|-----------|
| (1) Fuel filter lever | (A) "OFF" |
| (2) Fuel filter pot   | (B) "ON"  |

2. Remove the fuel filter pot and clean the inside with diesel fuel.
3. Take out the fuel filter and clean it with diesel fuel.
4. After cleaning, install the fuel filter, keeping out of dust at all times.
5. Air-bleed the fuel system.

**IMPORTANT :**

- Engine oil can cause a malfunction of the fuel injection pump. Wash the fuel filter with clean diesel fuel.



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- (1) O ring
- (2) Filter element
- (3) Spring
- (4) Filter bowl
- (5) Screw ring

## ENGINE OIL



### CAUTION

To avoid personal injury:

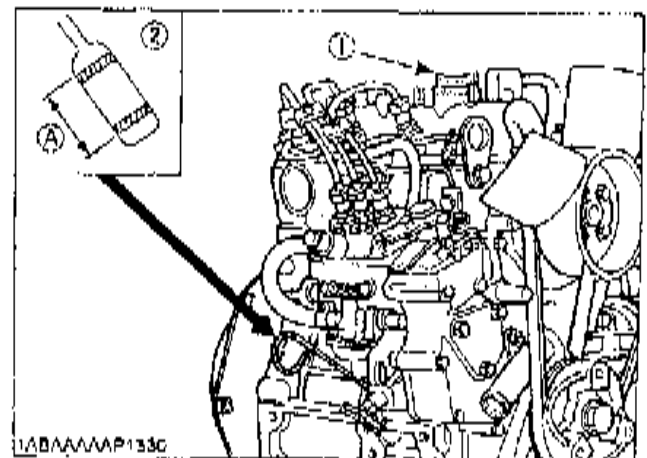
- Be sure to stop the engine before checking and changing the engine oil and the oil filter cartridge.
- Do not touch muffler or exhaust pipes while they are hot; Severe burns could result. Always stop the engine and allow it to cool before conducting inspections, maintenance, or for a cleaning procedure.
- Contact with engine oil can damage your skin. Put on gloves when using engine oil. If you come in contact with engine oil, wash it off immediately.

### NOTE:

- Be sure to inspect the engine, locating it on a horizontal place. If placed on gradients accurately, oil quantity may not be measured.
- Be sure to keep the oil level between upper and lower limits of the oil gauge. Too much oil may cause a drop in output or excessive blow-by gas. On the closed breather type engine in which mist is sucked through port, too much oil may cause oil hammer. While too little oil, may seize the engine's rotating and sliding parts. (The closed breather is an option.)

### ■ Checking level and adding engine oil

1. Check the engine oil level before starting or more than 5 minutes after stopping the engine.
2. Remove the oil level gauge, wipe it clean and reinstall it.
3. Take the oil level gauge out again, and check the oil level.



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- (1) Oil filler plug
- (2) Oil level gauge

[Lower end of oil level gauge]  
(A) Engine oil level within this range is proper.

4. If the oil level is too low, remove the oil filler plug, and add new oil to the prescribed level.
5. After adding oil, wait more than 5 minutes and check the oil level again. It takes some time for the oil to come down to the oil pan.

Engine oil quantity

Models	Oil pan depth	
	*101 mm (3.98 in.)	121 mm (4.76 in.)
Z482-E	2.1 L (0.55 U.S.gals.)	2.5 L (0.66 U.S.gals.)
D662-E D722-E	3.2 L (0.84 U.S.gals.)	3.8 L (1.0 U.S.gals.)
D782-E	-	3.6 L (0.95 U.S.gals.)
Z602-E	101 mm (3.98 in.)	-
	2.5 L (0.66 U.S.gals.)	
D902-E	101 mm (3.98 in.)	-
	3.7 L (0.98 U.S.gals.)	

\*101mm(3.98in.) oil pan depth is optional.

Oil quantities shown are for standard oil pans.

**IMPORTANT :**

- Engine oil should be MIL-L-2104C or have properties of API classification CD grades or higher. Change the type of engine oil according to the ambient temperature.

above 25° C (77° F)	SAE30 or SAE10W-30 SAE10W-40
0° C to 25° C (32° F to 77° F)	SAE20 or SAE10W-30 SAE10W-40
below 0° C (32° F)	SAE10 or SAE10W-30 SAE10W-40

- When using oil different from the previous one, be sure to drain all the previous oil before adding the new engine oil.

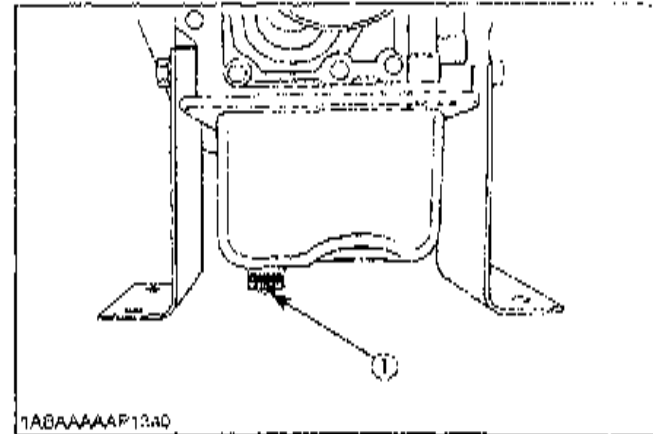
■ Changing engine oil



**CAUTION**

To avoid personal injury:

- Be sure to stop the engine before draining engine oil.
  - When draining engine oil, place some container underneath the engine and dispose it according to local regulations.
  - Do not drain oil after running the engine. Allow engine to cool down sufficiently.
1. Change oil after the initial 50 hours of operation and every 100 hours thereafter.
  2. Remove the drain plug at the bottom of the engine, and drain all the old oil. Drain oil easier and completely while the engine is hot.



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(1) Oil drain plug

3. Add new engine oil up to the upper limit of the oil level gauge.

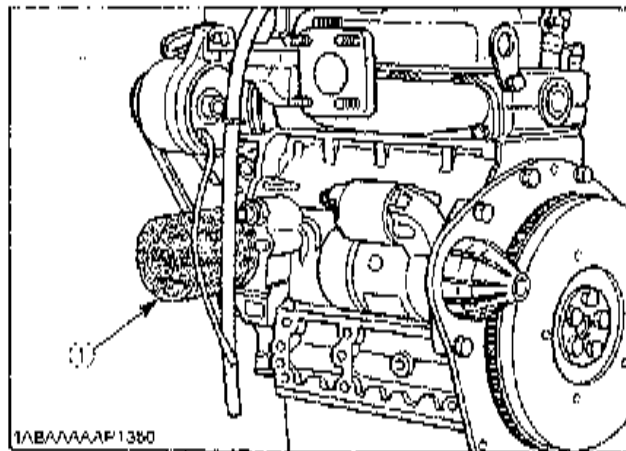
## ■ Replacing the oil filter cartridge

### ⚠ CAUTION

To avoid personal injury:

- Be sure to stop the engine before changing the oil filter cartridge.
- Allow engine to cool down sufficiently, oil can be hot and cause burns.

1. Replace the oil filter cartridge after the initial 50 hours of operation and every 200 hours thereafter.
2. Remove the old oil filter cartridge with a filter wrench.
3. Apply a film of oil to the gasket for the new cartridge.
4. Screw in the cartridge by hand. When the gasket contacts the seal surface, tighten the cartridge enough by hand. Because, if you tighten the cartridge with wrench, it will be tightened too much.



- (f) Oil filter cartridge  
Remove with a filter wrench  
(Tighten with your hand)

5. After the new cartridge has been replaced, the engine oil level normally decreases a little. Thus, run the engine for a while and check oil leaks through the seal before checking the engine oil level. Add oil if necessary.

#### NOTE :

- Wipe off any oil sticking to the machine completely.

## RADIATOR

Coolant will last for one day's work if filled all the way up before operation start. Make it a rule to check the coolant level before every operation.

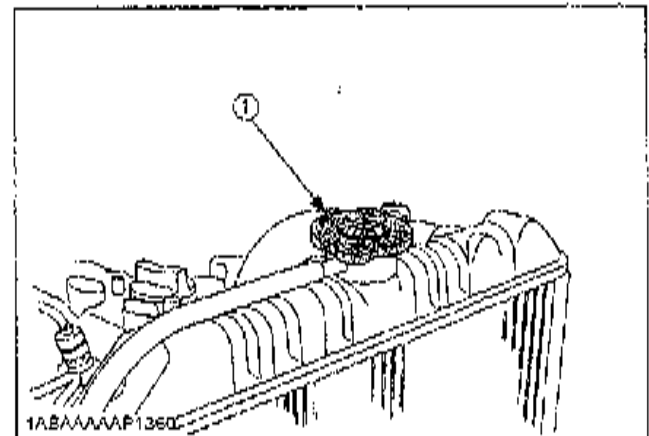
### ⚠ WARNING

To avoid personal injury:

- Do not stop the engine suddenly, stop it after about 5 minutes of unloaded idling.
- Work only after letting the engine and radiator cool off completely (more than 30 minutes after it has been stopped).
- Do not remove the radiator cap while coolant is hot. When cool to the touch, rotate cap to the first stop to allow excess pressure to escape. Then remove cap completely. If overheats should occur, steam may gush out from the radiator or reserve tank; Severe burns could result.

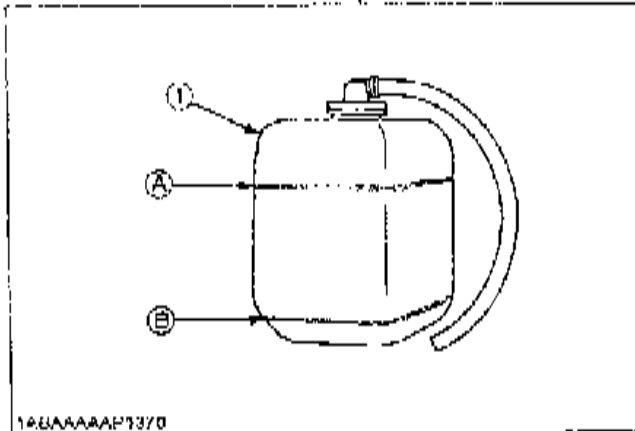
## ■ Checking coolant level, adding coolant

1. Remove the radiator cap after the engine has completely cooled, and check to see that coolant reaches the supply port.



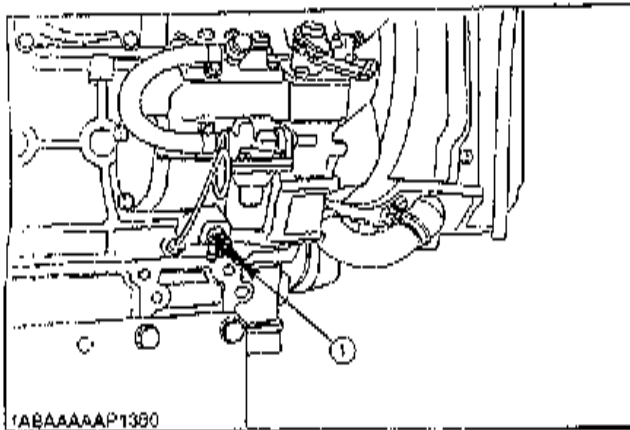
- (1) Radiator pressure cap

2. If the radiator is provided with a reserve tank, check the coolant level of the reserve tank. When it is between the "FULL" and "LOW" marks, the coolant will last for one day's work.

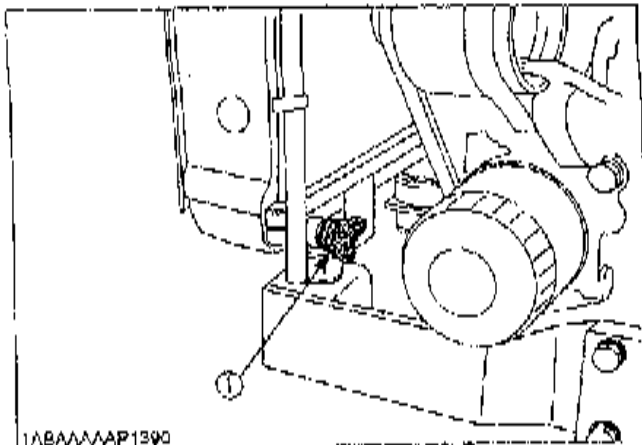


(1) Reserve tank  
 (A) "FULL"  
 (B) "LOW"

3. When the coolant level drops due to evaporation, add water only up to the full level.
4. Check to see that two drain cocks; one is at the crankcase side and the other is at the lower part of the radiator as figures below.



(1) Drain cock



(1) Drain cock

(1) Coolant drain cock

**IMPORTANT:**

- If the radiator cap has to be removed, follow the caution and securely retighten the cap.
- If coolant should be leak, consult your local KUBOTA dealer.
- Make sure that muddy or sea water does not enter the radiator.
- Use clean, fresh water and 50% anti-freeze to fill the recovery tank.
- Do not refill reserve tank with coolant over the "FULL" level mark.
- Be sure to close the radiator cap securely. If the cap is loose or improperly closed, coolant may leak out and decrease quickly.

### ■ Changing coolant

1. To drain coolant, always open both drain cocks and simultaneously open the radiator cap as well. With the radiator cap kept closed, a complete drain of water is impossible.
2. Remove the overflow pipe of the radiator pressure cap to drain the reserve tank.
3. Prescribed coolant volume (U.S.gallons)

Models	Quantity
Z482-E, Z602-E	2.8L (0.74 U.S.gals.)
D662-E, D722-E, D782-E, D902-E	3.1L (0.82 U.S.gals.)

#### NOTE :

- Coolant quantities shown are for standard radiators.
4. An improperly tightened radiator cap or a gap between the cap and the seat quickens loss of coolant.
  5. Coolant (Radiator cleaner and anti-freeze)

Season	Coolant
Summer	Pure water and radiator cleaner
Winter (when temperature drops below 0° C (32° F) or all season)	Pure water and anti-freeze (See "Anti-freeze" in Maintenance Section)

### ■ Checking radiator hoses and clamp



#### CAUTION

To avoid personal injury:

- Be sure to check radiator hoses and hose clamps periodically. If radiator hose is damaged or coolant leaks, overheats or severe burns could occur.

Check to see if radiator hoses are properly fixed every 200 hours of operation or 6 months, whichever comes first.

1. If hose clamps are loose or water leaks, tighten hose clamp securely.
  2. Replace hoses and tighten hose clamps securely, if radiator hoses are swollen, hardened or cracked.
- Replace hoses and hose clamps every 2 years or earlier, if checked and found that hoses are swollen, hardened or cracked.

### ■ Precaution at overheating

Take the following actions in the event the coolant temperature be nearly or more than the boiling point, what is called "Overheating". Take these actions if the engine's alarm buzzer sounds or the alarm lamp lights up.

1. Stop the engine operation in a safe place and keep the engine unloaded idling.
2. Do not stop the engine suddenly. Stop it after about 5 minutes of unloaded idling.
3. If the engine stalls within about 5 minutes of running under no load, immediately leave and keep yourself away from the machine. Never open the hood and any other part.
4. Keep yourself and others well away from the engine for further 10 minutes or while the steam blown out.
5. Checking that there gets no danger such as burn, get rid of the causes of overheating according to the manual, see "Troubleshooting" section. And then, start again the engine.

### ■ Anti-freeze



#### CAUTION

To avoid personal injury:

- When using anti-freeze, put on some protection such as rubber gloves.
- If should drink anti-freeze, throw up at once and take medical attention.
- When anti-freeze comes in contact with the skin or clothing, wash it off immediately.
- Do not mix different types of anti-freeze.
- Keep fire and children away from anti-freeze.
- Be mindful of the environment and ecology. Before draining any fluids, find out the correct way of disposing by checking with local codes.
- Also, observe the relevant environmental protection regulations when disposing of oil, fuel, coolant, brake fluid, filters and batteries.

If it freezes, coolant can damage the cylinders and radiator. It is necessary, if the ambient temperature falls below 0° C (32° F), to remove coolant after operating or to add anti-freeze to it.

1. There are 2 types of anti-freeze available; use the permanent type (PT) for this engine.
2. Before adding anti freeze for the first time, clean the radiator interior by pouring fresh water and draining it a few times.
3. The procedure for mixing of water and anti-freeze differs according to the make of the anti-freeze and the ambient temperature. Refer to SAF J1034 standard, more specifically also to SAF J814c.
4. Mix the anti-freeze with water, and then fill in to the radiator.

**IMPORTANT :**

- When the anti-freeze is mixed with water, the anti-freeze mixing ratio must be less than 50%.

Vol % Anti-freeze	Freezing Point		Boiling Point *	
	°C	°F	°C	°F
40	-24	-12	106	222
50	-37	-31	108	226

\*At  $1.013 \times 10^5$  Pa (760mmHg) pressure (atmospheric). A higher boiling point is obtained by using a radiator pressure cap which permits the development of pressure within the cooling system.

**NOTE :**

- The above data represent industry standards that necessitate a minimum glycol content in the concentrated anti-freeze.
- When the coolant level drops due to evaporation, add water only to keep the anti-freeze mixing ratio less than 50%. In case of leakage, add anti-freeze and water in the specified mixing ratio before filling into the radiator.
- Anti-freeze absorbs moisture. Keep unused anti-freeze in a tightly sealed container.
- Do not use radiator cleaning agents when anti-freeze has been added to the coolant. (Anti-freeze contains an anti-corrosive agent, which will react with the radiator cleaning agent forming sludge which will affect the engine parts.)

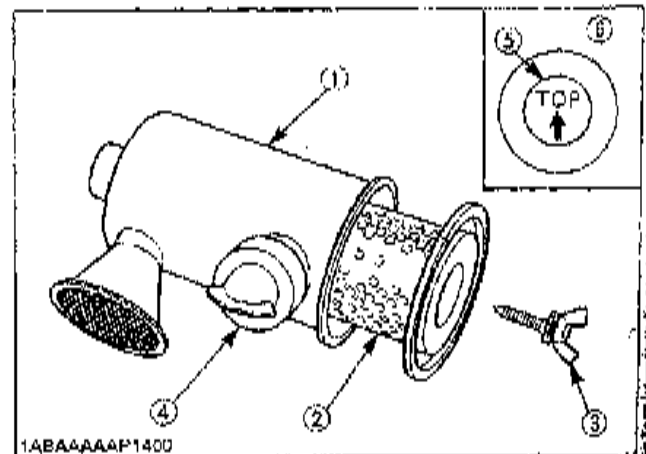
**■ Radiator cement**

As the radiator is solidly constructed, there is little possibility of water leakage. Should this happen, however, radiator cement can easily fix it. If leakage is serious, contact your local KUBOTA dealer.

**AIR CLEANER**

As the element of the air cleaner employed on this engine is a dry type, never apply oil to it.

- Open the evacuator valve once a week under ordinary conditions or daily when used in a dusty place to get rid of large particles of dust and dirt.
- Wipe the inside air cleaner clean with cloth or the like if it is dirty or wet.
- Avoid touching the element except when cleaning.
- When dry dust adheres to the element, blow compressed air from the inside turning the element. Pressure of compressed air must be under 205kPa (2.1kgf/cm<sup>2</sup>, 30psi).
- When carbon or oil adheres to the element, soak the element in detergent for 30 minutes, then wash it several times in water, rinse with clean water and dry it naturally.
- After element is fully dried, inspect inside of the element with a light and check if it is damaged or not. (referring to the instructions on the label attached to the element.)
- Replace the element every year or every six cleanings.



- 14BA444AP1400
- Air cleaner body
  - Element
  - Wing bolt
  - Evacuator valve
  - "TOP" mark
  - Dust cup

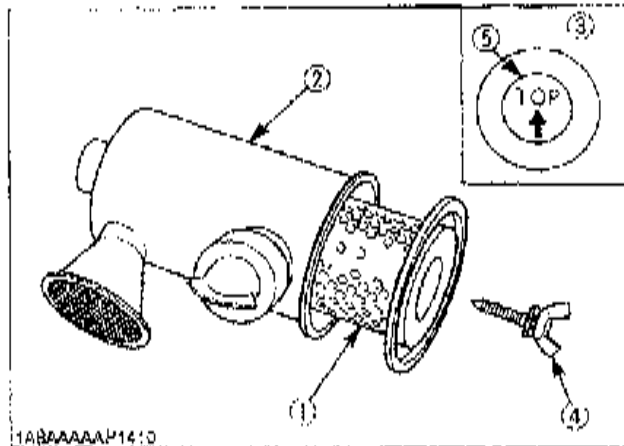
**IMPORTANT :**

- Make sure the wing bolt for the element is tight enough. If it is loose, dust and dirt may be sucked, wearing down the cylinder liner and piston ring surface and thereby resulting in poor power output.

■ For the air cleaner with a dust cup (optional)

Remove and clean out the dust cup before it becomes half full with dust; usually once a week, or even every day if the working surroundings are dusty.

Install the air cleaner dust cup with "TOP" indicated on the rear of the cup in the upside. (However, it may be installed in either direction when the cover is placed at the lower part.)



1ABAAAAAP1410

- (1) Element
- (2) Air cleaner body
- (3) Dust cup
- (4) Wing bolt
- (5) "TOP" mark

**IMPORTANT :**

- If the dust cup is mounted incorrectly, dust or dirt does not collect in the cup, and direct attachments of the dust to the element will cause its lifetime to shorten to a great extent.

**BATTERY**

**CAUTION**

To avoid personal injury:

- Be careful not to let the battery electrolyte contact your body or clothing.
- Wear eye protection and rubber gloves, since the diluted sulfuric acid solution burns skin and eats holes in clothing. Should this occur, immediately wash it off with running water and get medical attention.

Mishandling of the battery shortens the service life and adds to maintenance costs. Obtain the maximum performance and the longest life of the battery by handling properly and with care.

Engine starting will be more difficult, if the battery charge is low. Be careful to recharge it at an early occasion before it is too late.

■ Battery charging

**DANGER**

The battery comes in two types: refillable and non-refillable.

- For using the refillable type battery, follow the instructions below.

Do not use or charge the battery if its fluid level stands below the LOWER (lower limit level) mark.

Otherwise, the battery component parts may deteriorate earlier than expected, which may shorten the battery's service life or cause an explosion.

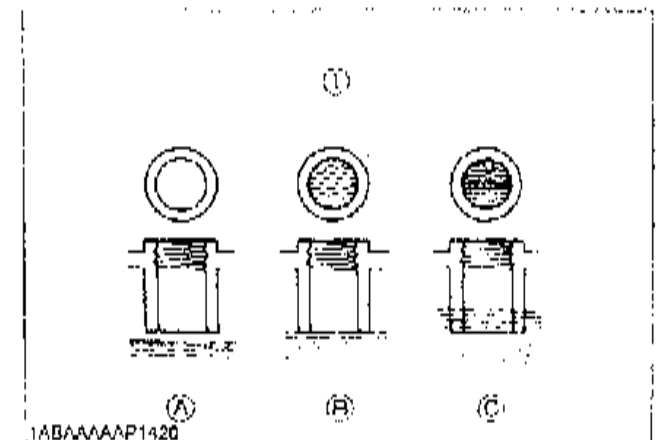
Immediately, add distilled water until the battery's fluid level is between the UPPER and LOWER levels.

**CAUTION**

To avoid personal injury:

- When the battery is being activated, hydrogen and oxygen gases in the battery are extremely explosive. Keep open sparks and flames away from the battery at all times, especially when charging the battery.
- When charging the battery, remove the battery vent plugs.
- When disconnecting the cable from the battery, start with the negative terminal, and when connecting them, start with the positive terminal first.
- DO NOT check the battery charge by placing a metal object across the terminals. Use a voltmeter or hydrometer.

1. Make sure each electrolyte level is to the bottom of vent wells. If necessary, add only distilled water in a well-ventilated place.

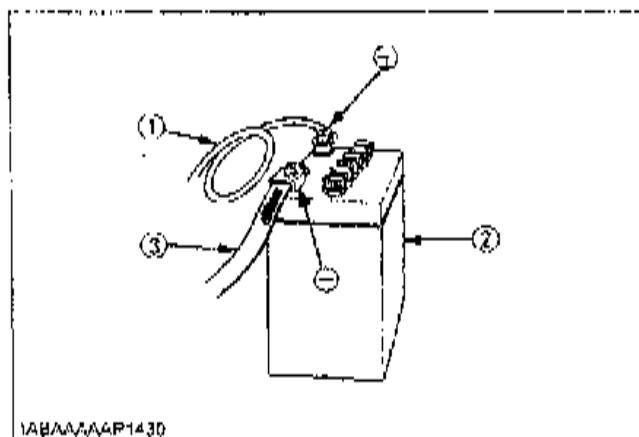


1ABAAAAAP1420

- (1) Battery electrolyte level
- (A) "TOO LOW"
- (B) "PROPER"
- (C) "TOO HIGH"

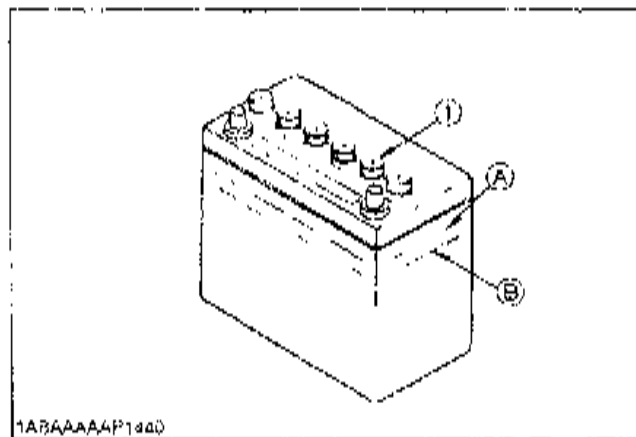


- 2 To slow charge the battery, connect the charger positive terminal to the battery positive terminal, and negative to the negative.
3. Quick recharging charges the battery at a high rate in a short time. As this is only for emergencies.
- 4 Recharge the battery as early as possible, or battery life will be extremely shortened.
5. When exchanging an old battery into new one, use battery of equal specification shown in page 26.



1ABAAAAP1430

- (1) Thick black cable
- (2) Battery case
- (3) Earth cable



1ABAAAAP1440

- (1) Plug
- (A) "HIGHEST LEVEL"
- (B) "LOWEST LEVEL"

**IMPORTANT :**

- ◆ Connect the charger positive terminal to the battery positive terminal, and negative to the negative.
- ◆ When disconnecting the cable from the battery, start with the negative terminal first.

When connecting the cable to the battery, start with the positive terminal first

If reversed, the contact of tools on the battery may cause a short.

**Direction for long term storage**

1. When storing the engine for long periods of time, remove the battery, adjust the electrolyte to the proper level, and store in a dry and dark place.
2. The battery naturally discharges while it is stored. Recharge it once a month in summer, and every 2 months in winter.

**ELECTRIC WIRING****CAUTION**

To avoid personal injury:

- ◆ Shorting of electric cable or wiring may cause a fire.
    - Check to see if electric cables and wiring are swollen, hardened or cracked.
    - Keep dust and water away from all power connections.
- Loose wiring terminal parts, make bad connections. Be sure to repair them before starting the engine.

Damaged wiring reduces the capacity of electrical parts. Change or repair damaged wiring immediately.

## FAN BELT

### ■ Adjusting Fan Belt Tension



#### CAUTION

To avoid personal injury:

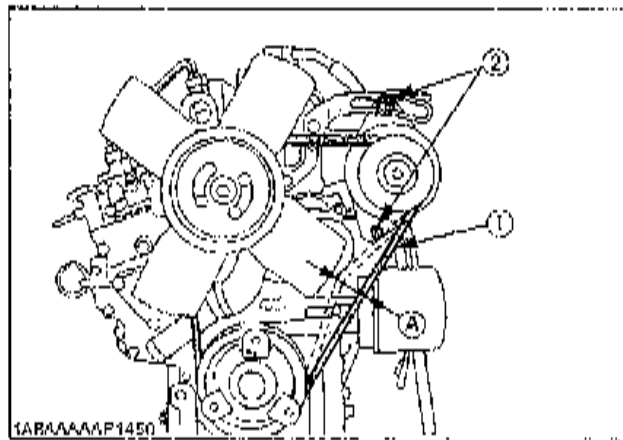
- Be sure to stop the engine and remove the key before checking the belt tension.
- Be sure to reinstall the detached safety shield after maintenance or checking.

Proper fan belt tension	A deflection of between 7 to 9 mm (0.28 to 0.35 in.) when the belt is pressed in the middle of the span.
-------------------------	--

1. Stop the engine and remove the key.
2. Apply moderate thumb pressure to belt between the pulleys.
3. If tension is incorrect, loosen the alternator mounting bolts and, using a lever placed between the alternator and the engine block, pull the alternator out until the deflection of the belt falls within acceptable limits.
4. Replace fan belt if it is damaged.

#### IMPORTANT :

- If belt is loosen or damaged and the fan is damaged, it could result in overheats or insufficient charging. Correct or replace belt.



- (1) Fan belt  
 (2) Bolt and nut  
 (A) 7 to 9 mm (0.28 to 0.35 in.)  
 (under load of 10 kgf (22.1 lbs))

# CARRIAGE AND STORAGE

## CARRIAGE



### CAUTION

To avoid personal injury:

- Fix the engine securely not to fall during operation.
  - Do not stand near or under the engine while carrying it.
  - The engine is heavy. In handling it, be very alert not to get your hands and body caught in.
1. Use carrier such as crane when carrying the engine, or hurt your waist and yourself. Support the engine securely with rope not to fall while carrying it.
  2. When lifting the engine, put the hook securely to metal fittings attached to the engine. Use strong hook and fittings enough to hang the engine.

## STORAGE



### CAUTION

To avoid personal injury:

- Do not clean the machine with engine running.
- To avoid the danger of exhaust fume poisoning, do not operate the engine in a closed building without proper ventilation.
- When storing the engine just after running, let the engine cool off.

Before storing the engine for more than a few months, remove any dirt on the machine, and:

1. Drain the coolant in the radiator. Open the cock at the bottom of the radiator, and remove the pressure cap to drain water completely. Leave the cock open. Hang a note written "No water" on the pressure cap. Since water may freeze when the temperature drops below 0° C (32° F), it is very important that no water is left in the machine.
2. Remove dirty engine oil, fill with new oil and run the engine for about 5 minutes to let the oil penetrate to all the parts.
3. Check all the bolts and nuts, and tighten if necessary.
4. Remove the battery from the engine, adjust the electrolyte level, and recharge it. Store the battery in a dry and dark place.
5. When the engine is not used for a long period of time, run it for about 5 minutes under no load every 2 to 3 months to keep it free from rust. If the engine is stored without any running, moisture in the air may condense into dew over the sliding parts of the engine, resulting in rust there.
6. If you forget to run the engine for longer than 5 to 6 months, apply enough engine oil to the valve guide and valve stem seal and make sure the valve works smoothly before starting the engine.
7. Store the engine in a flat place and remove the key from engine.
8. Do not store the engine in a place where has flammable materials such as dry grass or straw.
9. When covering the engine for storage, let engine and muffler cool off completely.
10. Operate the engine after checking and repairing damaged wirings or pipes, and clearing flammable materials carried by mouse.

# TROUBLESHOOTING

If the engine does not function properly, use the following chart to identify and correct the cause.

## ■ When it is difficult to start the engine

Cause	Countermeasures
Fuel is thick and doesn't flow.	*Check the fuel tank and fuel filter. *Remove water, dirt and other impurities. *As all fuel will be filtered by the filter, if there should be water or other foreign matters on the filter, clean the filter with kerosene.
Air or water mixed in fuel system	*If air is in the fuel filter or injection lines, the fuel pump will not work properly. To attain proper fuel injection pressure, check carefully for loosened fuel line coupling, loose cap nut, etc. *Loosen air vent screws atop fuel filter and fuel injection pump to eliminate all the air in the fuel system.
Thick carbon deposits on orifice of injection nozzle.	*This is caused when water or dirt is mixed in the fuel. Clean the nozzle injection piece, being careful not to damage the orifice. *Check to see if nozzle is working properly or not. If not, install a new nozzle.
Valve clearance is wrong.	*Adjust valve clearance to 0.145-0.185mm(0.0057-0.0072in) when the engine is cold.
Leaking valves	*Grind valve.
Fuel injection timing is wrong.	*Adjust injection timing *The injection timing is 0.366 rad(21°) before top dead center.
Engine oil becomes thick in cold weather and engine cranks slow.	*Change grade of oil according to the weather (temperature.)
Low compression	*Bad valve or excessive wear of rings, pistons and liners cause insufficient compression. Replace with new parts.
Battery is discharged and the engine will not crank.	*Charge battery. *In winter, always remove battery from machine, charge fully and keep indoors. Install in machine at time of use.

## ■ When output is insufficient

Cause	Countermeasures
Carbon stuck around orifice of nozzle piece	*Clean orifice and needle valve, being very careful not to damage the nozzle orifice. *Check nozzle to see if good. If not, replace with new parts.
Compression is insufficient. Leaking valves	*Bad valve and excessive wear of rings, pistons and liners cause insufficient compression. Replace with new parts. *Grind valves.
Fuel is insufficient.	*Check fuel system.
Overheating of moving parts	*Check lubricating oil system. *Check to see if lubricating oil filter is working properly. *Filter element deposited with impurities would cause poor lubrication. Change element. *Check the clearance of bearing arc within factory specs. *Check injection timing. *Adjust timing 0.366 rad(21°) before top dead center.
Valve clearance is wrong.	*Adjust to proper valve clearance of 0.145 to 0.185 mm(0.0057 to 0.0072 in.) with engine cold.
Air cleaner is dirty	*Clean the element every 100 hours of operation.
Fuel injection pressure is wrong.	*Adjust to proper pressure. 13.7Mpa (140 kgf/cm <sup>2</sup> ; 1991 psi)
Injection pump wear	*Do not use poor quality fuel for it will cause wear of the pump. Only use No. 2-D diesel fuel. *Check the fuel injection pump element and delivery valve assembly and replace as necessary.

### NOTE:

- If the cause of trouble can not be found, contact your KUBOTA dealer.

■ When engine suddenly stops

Cause	Countermeasures
Lack of fuel	*Check the fuel tank and refill the fuel, if necessary. *Also check the fuel system for air or leaks.
Bad nozzle	*If necessary, replace with a new nozzle.
Moving parts are overheated due to shortage of lubrication oil or improper lubrication.	*Check amount of engine oil with oil level gauge. *Check lubricating oil system. *At every 2 times of oil change, oil filter cartridge should be replaced. *Check to see if the engine bearing clearances is within factory specs.

NOTE :

- When the engine has suddenly stopped, decompress the engine by the decomp and turn the engine lightly by pulling on the fan belt. If the engine turns easily without abnormalities, the cause of the trouble is usually lack of fuel or bad nozzle.

■ When color of exhaust is especially bad

Cause	Countermeasures
Fuel governing device bad	*Contact dealer for repairs.
Fuel is of extremely poor quality.	*Select good quality fuel. Use No. 2-D diesel fuel only.
Nozzle is bad.	*If necessary, replace with new nozzle.
Combustion is incomplete.	*Cause is poor atomization, improper injection timing, etc. Because of trouble in injection system or in poor valve adjustment, or compression leakage, poor compression, etc. Check for the cause.

■ When engine must be stopped immediately

Cause	Countermeasures
Engine revolution suddenly decreases or increases.	*Check the adjustments, injection timing and the fuel system.
Unusual sound is heard suddenly.	*Check all moving parts carefully.
Color of exhaust suddenly turns dark.	*Check the fuel injection system, especially the fuel injection nozzle.
Bearing parts are overheated.	*Check the lubricating system.
Oil lamp lights up during operation.	*Check the lubricating system. *Check, if the engine bearing clearances are within factory specs. *Check the function of the relieve valve in the lubricating system. *Check pressure switch. *Check filter base gasket.

■ When engine overheats

Cause	Countermeasures
Engine oil insufficient	*Check oil level. Replenish oil as required.
Fan belt broken or elongated	*Change belt or adjust belt tension.
Coolant insufficient	*Replenish coolant.
Excessive concentration of antifreeze	*Add water only or change to coolant with the specified mixing ratio
Radiator net or radiator fin clogged with dust	*Clean net or fin carefully.
Inside of radiator or coolant flow route corroded	*Clean or replace radiator and parts.
Fan or radiator or radiator cap defective	*Replace defective parts.
Thermostat defective	*Check thermostat and replace if necessary.
Temperature gauge or sensor defective	*Check temperature with thermometer and replace if necessary.
Overload running	*Reduce load.
Head gasket defective or water leakage	*Replace parts.
Incorrect injection timing	*Adjust to proper timing.
Unsuitable fuel used	*Use the specified fuel.

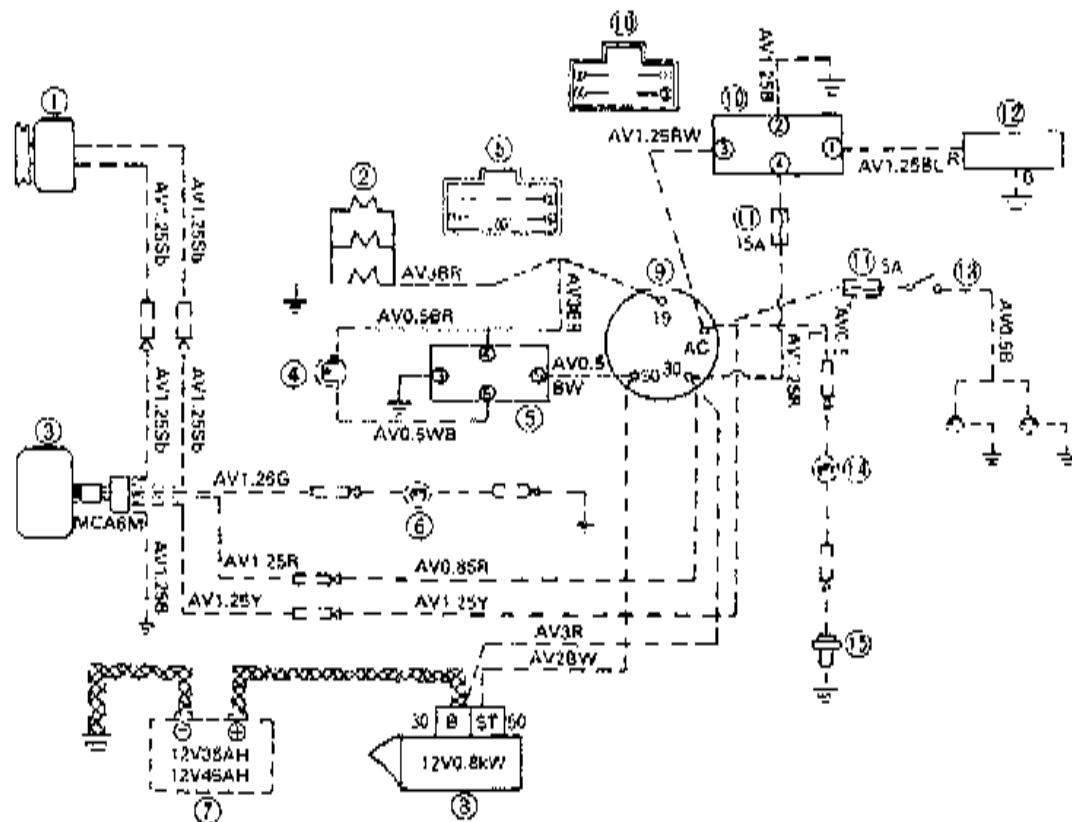
# SPECIFICATIONS

Model	74R7-F	2802-E	D852-E	D722-E	D702-E	D902-E
Type	Vertical, water-cooled, 4-cycle diesel engine					
Number of cylinders	2		3			
Bore and stroke mm (in.)	67 x 68 (2.64 x 2.69)	77 x 73.6 (2.03 x 2.90)	64 x 68 (2.52 x 2.68)	67 x 68 (2.64 x 2.68)	67 x 73.6 (2.64 x 2.90)	72 x 73.6 (2.83 x 2.90)
Total displacement l. (cu.in.)	0.479 (29.33)	0.598 (36.56)	0.656 (40.03)	0.719 (43.88)	0.778 (47.46)	0.898 (54.80)
Combustion chamber	Spherical Type (ETVCS)					
SAE NET Intermittent kW / rpm H.P. (SAEJ1349) (HP / rpm)	9.32 / 3600 (12.5 / 3600)	11.6 / 3600 (15.6 / 3600)	12.9 / 3600 (17.3 / 3600)	14.0 / 3600 (18.6 / 3600)	13.5 / 3200 (18.1 / 3200)	17.6 / 3600 (23.5 / 3600)
SAE NET Continuous kW / rpm H.P. (SAEJ1349) (HP / rpm)	8.05 / 3600 (10.8 / 3600)	10.1 / 3600 (13.5 / 3600)	11.10 / 3600 (15.0 / 3600)	12.15 / 3600 (16.3 / 3600)	11.7 / 3200 (15.7 / 3200)	15.2 / 3600 (20.4 / 3600)
Maximum bare speed rpm	3800	3850	3800		3450	3850
Maximum bare idling speed rpm	800 to 900	900 to 1000	800 to 900			900 to 1000
Order of firing	1-2		1-2-3			
Direction of rotation	Counter-clockwise (viewed from flywheel side)					
Injection pump	Bosch MD Type mini pump					
Injection pressure	13.73 MPa, 1991 psi (140 kg/cm <sup>2</sup> )					
Injection timing (Before T.D.C.)	0.366rad(21°)	0.35rad(20°)	0.366rad(21°)			0.35rad(20°)
Compression ratio	23 : 1	24 : 1	23 : 1			24 : 1
Fuel	Diesel Fuel No.2-D					
Lubricant (API classification)	above CC grade					
Dimension mm (in.) (length x width x height)	351 x 389 x 520 (13.82 x 15.31 x 20.47)	385 x 421 x 544 (15.16 x 16.57 x 21.42)	426 x 389 x 520 (16.77 x 15.31 x 20.47)			467 x 421 x 544 (18.39 x 16.57 x 21.42)
Dry weight (BB Spec.) kg (lbs.)	53.1 (117.1)	57.0 (125.7)	63.7 (140.4)	63.1 (139.1)	63.5 (140.0)	72.0 (159.7)
Starting system	Cell starter (with glow plug)					
Starting motor	12 V, 0.8 kW	12 V, 1.0 kW	12 V, 0.8 kW			12 V, 1.2 kW
Charging generator	12 V, 150 W	12 V, 480 W	12 V, 150 W			12 V, 480 W
Recommended battery capacity (5Hr capacity)	12 V, 28 AH, equivalent	12 V, 36 AH, equivalent				12 V, 52 AH, equivalent

**NOTE :**

- Specifications are subject to change without notice.
- The battery capacity is indicated in 5-hour ratio.

# WIRING DIAGRAMS



1ABA/AAAA/P145C

- |                                   |                             |
|-----------------------------------|-----------------------------|
| (1) Alternator                    | (9) Key switch              |
| (2) Glow plug                     | (10) Timer                  |
| (3) Regulator                     | (11) Fuse                   |
| (4) Lamp                          | (12) Solenoid               |
| (5) Lamp timer<br>(Option)        | (Option)                    |
| (6) Charge lamp<br>(3.4W or less) | (13) Switch                 |
| (7) Battery                       | (14) Lamp<br>(3.4W or less) |
| (8) Starter                       | (15) Oil switch             |

**NOTE:** Solenoid. Energize to stop.

CORD COLOR	
R	Black
G	Green
L	Blue
R	Red
Sb	Sky blue
W	White
Y	Yellow



## MATERIAL SAFETY DATA SHEET

### Section 1 - CHEMICAL, PRODUCT AND COMPANY IDENTIFICATION

Marketed and Distributed by:  
 CHS Inc.  
 P.O. Box 64089  
 Mail station 525  
 St. Paul, MN 55164-0089

Transportation Emergency (CHEMTREC): 1-800-424-9300  
 Technical Information: 1-651-306-8443  
 MSDS Information: 1-651-306-8438

PRODUCT NAME: ERC AW Hydraulic Oil, ISO (32, 46, 68, 100, 150)  
 COMMON NAME: Industrial hydraulic fluid  
 Approximate SAE grade 10W, 20, 30, 40

MSDS: 0124-F1B0-1 - Rev.A (4.6.99)  
 CHEMICAL FORMULA: Mixture

CHEMICAL NAME: Lubricating Oil

CHEMICAL FAMILY: Hydrocarbon

### Section 2 - COMPOSITION AND INFORMATION ON INGREDIENTS

INGREDIENTS	PERCENTAGES (by weight)	PEL (OSHA)	TLV (ACGIH)	CAS #
Oil, Solvent Neutral	30-98%	N/A	1 mg/m <sup>3</sup> TWA (Oil Mist)	64742-65-0
Oil, Bright Stock	0-60%	N/A	2 mg/m <sup>3</sup> TWA (Oil Mist)	64721-1-4
Performance Additives	Proprietary	N/A	N/A	

(TWA) - Time Weighted Average is the employee's average airborne exposure in any 8-hour work shift of a 40-hour work week which shall not be exceeded.  
 (STEL) - Short Term Exposure Limit is the employee's 15-minute time weighted average exposure which shall not be exceeded at any time during a work day unless another time limit is specified.

### Section 3 - HAZARDS IDENTIFICATION

#### EMERGENCY OVERVIEW

#### POTENTIAL HEALTH EFFECTS

ROUTES OF ENTRY: (Eye Contact, Dermal, Inhalation.)

#### ACUTE EFFECTS OF OVER EXPOSURE:

Eyes - Contact with eyes may cause irritation.

Skin - Contact with skin may cause irritation.

Inhalation - May cause irritation of the nose and throat.

Ingestion - May cause nausea and vomiting. Large quantities may affect the central nervous system.

CHRONIC EFFECTS OF OVER EXPOSURE: No adverse effects anticipated.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Existing dermatitis and respiratory conditions.

CARCINOGENICITY: NTP: No

IARC: No

OSHA: No



### Section 4 - FIRST AID MEASURES

#### EMERGENCY AND FIRST AID PROCEDURES:

**Eye Contact** - If material comes in contact with the eyes, immediately wash the eyes with large amounts of water for fifteen minutes, occasionally lifting the lower and upper lids. Get medical attention.

**Skin Contact** - If the material comes in contact with the skin, wash the contaminated skin with soap and water promptly. If the material penetrates through clothing, remove the clothing and wash the skin with soap and water promptly. If irritation persists after washing, get medical attention immediately.

**Inhalation** - If person breathes in large amounts of material, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the person warm and at rest. Get medical attention as soon as possible.

**Ingestion** - If material has been swallowed, do not induce vomiting. Get medical attention immediately.

### Section 5 - FIRE - FIGHTING MEASURES

**FLASH POINT:** >390°F (>200°C)

**AUTO IGNITION TEMP:** >400°F

**FLAMMABLE LIMITS IN AIR**  
% BY VOLUME

LOWER  
N/A

UPPER  
N/A

**EXTINGUISHING MEDIA:** Use water spray to cool fire exposed surfaces and to protect personnel. Use foam, dry chemical or water spray (fog) to extinguish fire.

**SPECIAL FIRE FIGHTING PROCEDURES:** When fighting fires wear full turnout gear and self contained breathing apparatus. Water may cause splattering. Material floats on water.

**UNUSUAL FIRE AND EXPLOSION HAZARDS:** Toxic fumes gases or vapors may evolve on burning.

**HAZARD RATINGS:** NFPA 704: Health- 1 Fire- 1 Reactivity- 0  
HMIS: Health-     Fire-     Reactivity-    

### Section 6 - ACCIDENTAL RELEASE MEASURES

**STEPS TO TAKE IF MATERIAL IS RELEASED OR SPILLED:** Personal protective equipment should be worn. Ventilate area if confined or poorly ventilated. Contain with dikes or absorbent to prevent migration to sewers/streams. Take up small spill with dry chemical absorbent; large spills may require pump or vacuum prior to absorbent. May require excavation of severely contaminated soil. Avoid contact with skin and eyes.

### Section 7 - HANDLING AND STORAGE

**HANDLING AND STORING:** Store in closed container away from all ignition sources. Handling temperatures should not exceed 175°F (80°C). Wash thoroughly after handling. Do not store at temperatures exceeding 113°F (45 C). Odorous and toxic fumes may form from the decomposition of this product if stored at excessive temperatures for extended periods of time. Open containers carefully and only in well ventilated areas or use appropriate respiratory protection. Store in well ventilated area.

## Section 8 - EXPOSURE CONTROL - PERSONAL PROTECTION

---

**ENGINEERING CONTROLS:** Ventilate to control mists and vapors below exposure limits.

**RESPIRATORY EQUIPMENT:** Normally not required, if exposure limits are exceeded use a NIOSH approved organic vapor respirator. Self contained breathing apparatus is recommended for entry into confined spaces or other poorly ventilated areas and for large spill clean-up sites.

**EYE PROTECTION:** Chemical goggles or faceshield recommended to minimize eye contact.

**PROTECTIVE CLOTHING:** Impervious (nitrile) gloves recommended when handling material to minimize exposure. Long sleeve shirts, chemically protective aprons and chemically protective boots are recommended for contact exposure or spill clean-up. Do not wear watches, rings or similar apparel that could entrap the material next to the skin.

**OTHER (SAFETY SHOWERS, EYE WASH STATIONS, ETC.):** Water should be available for flushing and washing when exposure exists. Launder soiled clothes. Discard shoes or other leather articles saturated with the material.

## Section 9 - PHYSICAL AND CHEMICAL PROPERTIES

---

**APPEARANCE:** Amber liquid

**ODOR:** Mild odor

**BOILING POINT:** N/D

**SPECIFIC GRAVITY (water=1):** 0.8400 - 0.8800

**VAPOR PRESSURE:** <1 mm Hg 68° F

**VAPOR DENSITY (air=1):** N/D

**SOLUBLE IN WATER:** Insoluble

**EVAPORATION RATE (ether=1):** <1

**pH:** N/D

## Section 10 - STABILITY AND REACTIVITY

---

**STABILITY:**

**STABLE**  (At room temperature and pressure. See handling and storage section)

**UNSTABLE**

**INCOMPATIBILITY -**

**CONDITIONS TO AVOID:** See handling and storage section.

**MATERIALS TO AVOID:** Acids, oxidizing agents.

**HAZARDOUS DECOMPOSITION PRODUCTS:** Smoke, carbon monoxide, aldehydes, hydrogen sulfide and alkyl mercaptans may be released. Under combustion conditions, oxides of the following elements will be formed: Magnesium, calcium, nitrogen, sulfur, carbon.

**HAZARDOUS POLYMERIZATION:** Will not occur.

## Section 11 - TOXICOLOGY INFORMATION

---

**Note:** CHS Inc. has not conducted specific toxicity tests on this product.

## Section 12 - ECOLOGICAL INFORMATION

---

**Note:** CHS Inc. has not conducted specific ecological tests on this product.

**Section 13 - DISPOSAL CONSIDERATION**

WASTE DISPOSAL PROCEDURES: Place contaminated materials in a disposable container and dispose of in accordance with Local, State and Federal environmental regulations.

**Section 14 - TRANSPORTATION**

DOT PROPER SHIPPING NAME: N/A

DOT HAZARD CLASS: N/A

DOT IDENTIFICATION NUMBER: N/A

DOT EMER. RESPONSE GUIDE NO.: N/A

**Section 15 - REGULATORY INFORMATION**

This product does contain toxic chemicals subject to the reporting requirements of SARA Section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 and of 40 CFR 372.

CAS Number

N982

Chemical Name

Zinc compounds

Percent by Weight

0.45% ( 0.03% as Zn)

*Below de minimus level*

SARA SECTION 311-312 HAZARD CATEGORIES (40 CFR 370.2):

FIRE: NoSUDDEN RELEASE OF PRESSURE: NoREACTIVE: NoACUTE: No CHRONIC: No**Section 16 - OTHER INFORMATION**Prepared By: Hue LamDATE: April 14, 1999Approved By: Marc SiebertSupersedes: N/ATitle: Manager, Quality SystemReason for Issue: CHS Inc. Marketer

THE INFORMATION CONTAINED IN THIS MSDS RELATES ONLY TO THE SPECIFIC MATERIAL IDENTIFIED. IT DOES NOT COVER USE OF THAT MATERIAL IN COMBINATION WITH ANY OTHER MATERIAL OR IN ANY PARTICULAR PROCESS. IN COMPLIANCE WITH 29 C.F.R. 1910.1200(g), CHS INC. HAS PREPARED THIS MSDS IN SEGMENTS, WITH THE INTENT THAT THOSE SEGMENTS BE READ TOGETHER AS A WHOLE WITHOUT TEXTUAL OMISSIONS OR ALTERATIONS. CHS INC. BELIEVES THE INFORMATION CONTAINED HEREIN TO BE ACCURATE, BUT MAKES NO REPRESENTATION, GUARANTEE, OR WARRANTY, EXPRESS OR IMPLIED, ABOUT THE ACCURACY, RELIABILITY, OR COMPLETENESS OF THE INFORMATION OR ABOUT THE FITNESS OF CONTENTS HEREIN FOR EITHER GENERAL OR PARTICULAR PURPOSES. PERSONS REVIEWING THIS MSDS SHOULD MAKE THEIR OWN DETERMINATION AS TO THE MATERIAL'S SUITABILITY AND COMPLETENESS FOR USE IN THEIR PARTICULAR APPLICATIONS.



# MATERIAL SAFETY DATA SHEET

## Section 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

CHS Inc.  
P.O. Box 64089  
Mail station 525  
St. Paul, MN 55164-0089

Transportation Emergency (CHEMTREC): 1-800-424-9300  
Technical Information: 1-651-355-8443  
MSDS Information: 1-651-355-8438

PRODUCT NAME: Turbine XL 22, 32, 46, 68, 100

MSDS: 0190-E1A0 - Rev. A (03/31/04)

COMMON NAME: Industrial turbine oil

CHEMICAL FORMULA: Mixture

CHEMICAL NAME: Lubricating Oil

CHEMICAL FAMILY: Hydrocarbon

## Section 2 - COMPOSITION AND INFORMATION ON INGREDIENTS

INGREDIENTS	PERCENTAGES (by weight)	PEL (OSHA)	TLV (ACGIH)	CAS #
Oil, Solvent Neutral	98-99%	N/A	3 mg/m <sup>3</sup> TWA (oil mist)	64742-65-0
Performance Additives	Proprietary	N/A	N/A	

(TWA) - Time Weighted Average is the employee's average airborne exposure in any 8-hour work shift of a 40-hour work week which shall not be exceeded.  
(STEL) - Short Term Exposure Limit is the employee's 15-minute time weighted average exposure which shall not be exceeded at any time during a work day unless another time limit is specified.

## Section 3 - HAZARDS IDENTIFICATION

### EMERGENCY OVERVIEW

### POTENTIAL HEALTH EFFECTS

ROUTES OF ENTRY: (Eye Contact, Dermal, Inhalation.)

### ACUTE EFFECTS OF OVER EXPOSURE:

Eyes - Contact with eyes may cause irritation.

Skin - Contact with skin may cause irritation.

Inhalation - May cause irritation of the nose and throat.

Ingestion - May cause nausea and vomiting. Large quantities may effect the central nervous system.

CHRONIC EFFECTS OF OVER EXPOSURE: No adverse effects anticipated.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Existing dermatitis and respiratory conditions.

CARCINOGENICITY: NTP: No

IARC: No

OSHA: No

### Section 4 - FIRST AID MEASURES

#### EMERGENCY AND FIRST AID PROCEDURES:

**Eye Contact** - If material comes in contact with the eyes, immediately wash the eyes with large amounts of water for 15 minutes, occasionally lifting the lower and upper lids. Get medical attention.

**Skin Contact** - If the material comes in contact with the skin, wash the contaminated skin with soap and water promptly. If the material penetrates through clothing, remove the clothing and wash the skin with soap and water promptly. If irritation persists after washing, get medical attention immediately.

**Inhalation** - If person breathes in large amounts of material, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the person warm and at rest. Get medical attention as soon as possible.

**Ingestion** - If material has been swallowed, do not induce vomiting. Get medical attention immediately.

### Section 5 - FIRE - FIGHTING MEASURES

FLASH POINT: >390°F (>200°C) AUTO IGNITION TEMP: >500° F

FLAMMABLE LIMITS IN AIR		<u>LOWER</u>	<u>UPPER</u>
% BY VOLUME	N/A	N/A	N/A

**EXTINGUISHING MEDIA:** Use water spray to cool fire exposed surfaces and to protect personnel. Use foam, dry chemical or water spray (fog) to extinguish fire.

**SPECIAL FIRE FIGHTING PROCEDURES:** When fighting fires wear full turnout gear and self contained breathing apparatus. Water may cause splattering. Material floats on water.

**UNUSUAL FIRE AND EXPLOSION HAZARDS:** Toxic fumes gases or vapors may evolve on burning.

HAZARD RATINGS:	NFPA 704:	Health- <u>1</u>	Fire- <u>1</u>	Reactivity- <u>0</u>
	HMS:	Health- <u>   </u>	Fire- <u>   </u>	Reactivity- <u>   </u>

### Section 6 - ACCIDENTAL RELEASE MEASURES

**STEPS TO TAKE IF MATERIAL IS RELEASED OR SPILLED:** Personal protective equipment should be worn. Ventilate area if confined or poorly ventilated. Contain with dikes or absorbent to prevent migration to sewers/streams. Take up small spill with dry chemical absorbent; large spills may require pump or vacuum prior to absorbent. May require excavation of severely contaminated soil. Avoid contact with skin and eyes.

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**OTHER (SAFETY SHOWERS, EYE WASH STATIONS, ETC):** Water should be available for flushing and washing when exposure exists. Launder soiled clothes. Discard shoes or other leather articles saturated with the material.

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**VAPOR DENSITY (air=1):** N/D

**SOLUBLE IN WATER:** Insoluble

**EVAPORATION RATE (ether=1):** <1

**pH:** N/D

## Section 10 - STABILITY AND REACTIVITY

---

**STABILITY:**

STABLE X (At room temperature and pressure. See handling and storage section)

UNSTABLE   

**INCOMPATIBILITY -**

**CONDITIONS TO AVOID:** See handling and storage section.

**MATERIALS TO AVOID:** Acids, oxidizing agents.

**HAZARDOUS DECOMPOSITION PRODUCTS:** Smoke, carbon monoxide, aldehydes, hydrogen sulfide and alkyl mercaptans may be released. Under combustion conditions, oxides of the following elements will be formed: Magnesium, calcium, nitrogen, sulfur, carbon.

**HAZARDOUS POLYMERIZATION:** Will not occur.

## Section 11 - TOXICOLOGY INFORMATION

---

**Note:** CHS has not conducted specific toxicity tests on this product.

## Section 12 - ECOLOGICAL INFORMATION

---

**Note:** CHS has not conducted specific ecological tests on this product.

**Section 13 - DISPOSAL CONSIDERATION**

**WASTE DISPOSAL PROCEDURES:** Place contaminated materials in a disposable container and dispose of in accordance with Local, State and Federal environmental regulations.

**Section 14 - TRANSPORTATION**

DOT PROPER SHIPPING NAME: N/A

DOT HAZARD CLASS: N/A

DOT IDENTIFICATION NUMBER: N/A

DOT EMER. RESPONSE GUIDE NO.: N/A

**Section 15 - REGULATORY INFORMATION**

This product (does/not) contain toxic chemicals subject to the reporting requirements of SARA Section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 and of 40 CFR 372.

<u>CAS Number</u>	<u>Chemical Name</u>	<u>Percent by Weight</u>
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SARA SECTION 311-312 HAZARD CATEGORIES (40 CFR 370.2):

FIRE: No SUDDEN RELEASE OF PRESSURE: No REACTIVE: No ACUTE: No CHRONIC: No**Section 16 - OTHER INFORMATION**Prepared By: Huc Lam DATE: March 31, 2004Title: EHS Compliance Specialist Supersedes: NAReason for Issue: NA

THE INFORMATION CONTAINED IN THIS MSDS RELATES ONLY TO THE SPECIFIC MATERIAL IDENTIFIED. IT DOES NOT COVER USE OF THAT MATERIAL IN COMBINATION WITH ANY OTHER MATERIAL OR IN ANY PARTICULAR PROCESS. IN COMPLIANCE WITH 29 C.F.R. 1910.1200(g), CHS HAS PREPARED THIS MSDS IN SEGMENTS, WITH THE INTENT THAT THOSE SEGMENTS BE READ TOGETHER AS A WHOLE WITHOUT TEXTUAL OMISSIONS OR ALTERATIONS. CHS BELIEVES THE INFORMATION CONTAINED HEREIN TO BE ACCURATE, BUT MAKES NO REPRESENTATION, GUARANTEE, OR WARRANTY, EXPRESS OR IMPLIED, ABOUT THE ACCURACY, RELIABILITY, OR COMPLETENESS OF THE INFORMATION OR ABOUT THE FITNESS OF CONTENTS HEREIN FOR EITHER GENERAL OR PARTICULAR PURPOSES. PERSONS REVIEWING THIS MSDS SHOULD MAKE THEIR OWN DETERMINATION AS TO THE MATERIAL'S SUITABILITY AND COMPLETENESS FOR USE IN THEIR PARTICULAR APPLICATIONS.



Ceres® is a registered trademark of CHS Inc.

**THORWORKS 100 CFM ENGINE-DRIVE  
AIR COMPRESSOR  
OPERATOR, INSTALLATION,  
AND PARTS MANUAL**



## **SAFETY**

### **WARNING**

**ALL UNITS ARE SHIPPED WITH A DETAILED OPERATORS AND PARTS MANUAL. THIS MANUAL CONTAINS VITAL INFORMATION FOR THE SAFE USE AND EFFICIENT OPERATION OF THIS UNIT. CAREFULLY READ THE OPERATORS MANUAL BEFORE STARTING THE UNIT. FAILURE TO ADHERE TO THE INSTRUCTIONS COULD RESULT IN SERIOUS BODILY INJURY OR PROPERTY DAMAGE.**

### **AIR COMPRESSOR SAFETY PRECAUTIONS**

Safety is basically common sense. While there are standard safety rules, each situation has its own peculiarities that cannot always be covered by rules. Therefore with your experience and common sense, you are in a position to ensure your safety. Lack of attention to safety can result in: accidents, personal injury, reduction of efficiency and worst of all - Loss of Life. Watch for safety hazards. Correct them promptly. Use the following safety precautions as a general guide to safe operation:

Do not attempt to remove any compressor parts without first relieving the entire system of pressure.

Do not attempt to service any part while machine is operating.

### **DANGER**

**CHECK THE COMPRESSOR SUMPOIL LEVEL ONLY WHEN THE COMPRESSOR IS NOT OPERATING AND SYSTEM IS COMPLETELY RELIEVED OF PRESSURE. OPEN SERVICE VALVE TO ENSURE RELIEF OF SYSTEM AIR PRESSURE WHEN PERFORMING MAINTENANCE ON COMPRESSOR AIR/OIL SYSTEM. FAILURE TO COMPLY WITH THIS WARNING MAY CAUSE DAMAGE TO PROPERTY AND SERIOUS BODILY HARM.**

Do not operate the compressor at pressure or speed in excess of its rating as indicated in "Compressor Specifications".

Periodically check all safety devices for proper operation.

Do not play with compressed air. Pressurized air can cause serious injury to personnel.

Exercise cleanliness during maintenance and when making repairs. Keep dirt away from parts by covering parts and exposed openings.

## **SAFETY**

Do not install a shut-off valve between the compressor and compressor oil sump.

### **DANGER**

**DO NOT USE BOSS INDUSTRIES COMPRESSOR SYSTEMS TO PROVIDE BREATHING AIR. SUCH USAGE, WHETHER SUPPLIED IMMEDIATELY FROM THE COMPRESSOR SOURCE, OR SUPPLIED TO BREATHING TANKS FOR SUBSEQUENT USE, CAN CAUSE SERIOUS BODILY INJURY.**

**BOSS INDUSTRIES DISCLAIMS ANY AND ALL LIABILITIES FOR DAMAGE FOR LOSS DUE TO PERSONAL INJURIES, INCLUDING DEATH, AND/OR PROPERTY DAMAGE INCLUDING CONSEQUENTIAL DAMAGES ARISING OUT OF ANY BOSS INDUSTRIES COMPRESSORS USED TO SUPPLY BREATHING AIR.**

Do not disconnect or bypass safety circuit system.

Do not install safety devices other than authorized BOSS INDUSTRIES replacement devices.

Close all openings and replace all covers and guards before operating compressor unit.

Tools, rags, or loose parts must not be left on the compressor or drive parts.

Do not use flammable solvents for cleaning parts.

Keep combustibles out of and away from the Compressor and any associated enclosures.

The owner, lessor, or operator of the Compressor are hereby notified and forewarned that any failure to observe these safety precautions may result in damage or injury.

BOSS INDUSTRIES expressly disclaims responsibility or liability for any injury or damage caused by failure to observe these specified precautions or by failure to exercise that ordinary caution and due care required when operating or handling the Compressor, even though not expressly specified above.

## SAFETY

A compliment of warning decals is supplied with each unit. These decals must be affixed to the vehicle after it has been painted, trimmed, and undercoat, etc. and prior to being put into service. The decals shall be placed so as to be clearly visible to the user and service personnel. (Figures 1 through 6.)

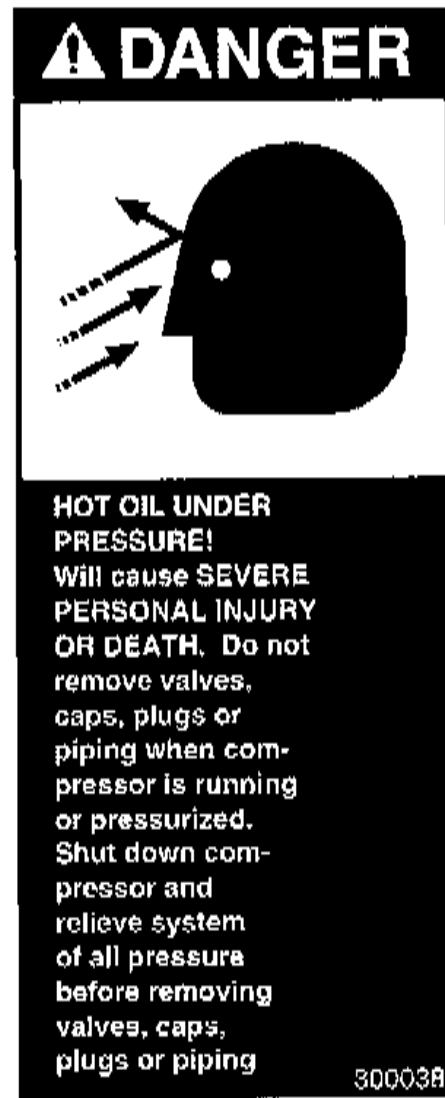
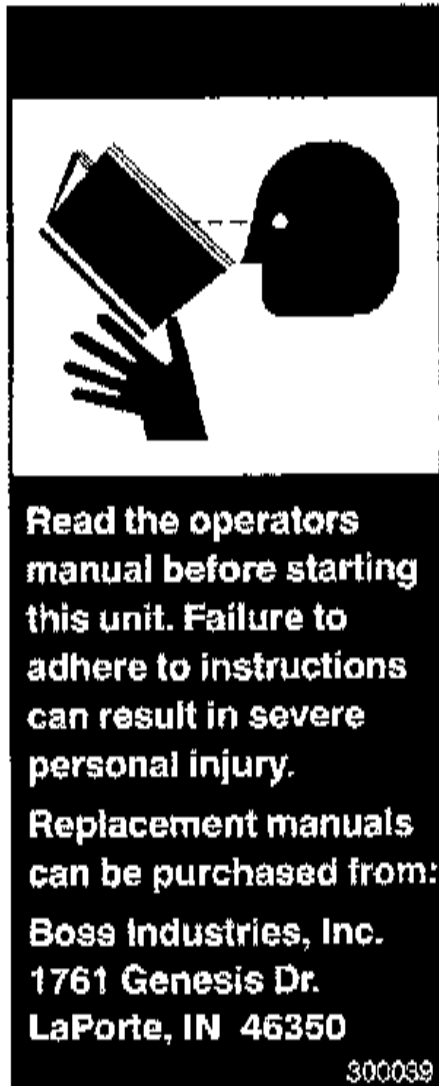


Figure 2. To be placed on body near oil sump filler cap.

## SAFETY



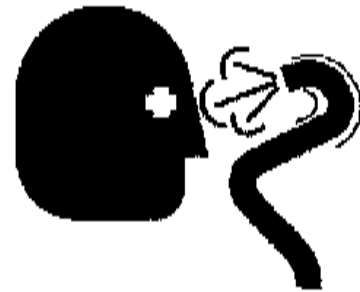
Figure 3. To be placed on body near air service valve.

## SAFETY



**Do not  
operate  
without  
fan guard  
in place.**

300041



**Connect air hoses only  
in full compliance  
with OSHA Standard 29  
CFR 1926:(b)(7)  
The required safety  
devices should be  
tested in accordance  
with their manufacturer's  
recommendations  
to verify that they  
reduce pressure in  
case of hose failure  
and will not nuisance  
trip with the hose  
and tool combinations  
in use.**

300042

SAFETY

**COMPRESSOR FLUID**

**USE AUTOMATIC TRANSMISSION FLUID  
DEXRON III OR EQUIVALENT.**

- 1. CHECK FLUID LEVEL WITH TRUCK OFF  
AND PARKED ON LEVEL GROUND BEFORE  
STARTING COMPRESSOR.**
- 2. ADD FLUID IF NONE IS SHOWING IN  
SIGHTGLASS.**
- 3. DO NOT FILL ABOVE LINE ON SIGHTGLASS**

300047



BOSS INDUSTRIES, INC.

1761 GENESIS DR. LA PORTE, IN 46350

1-800-635-6587

WWW.BOSSAIR.COM

**SERIAL NO.**

1761

## **COMPRESSOR TERMINOLOGY**

**ATF** - Automatic transmission fluid.

**CFM** - The volume of compressed air produced expressed as cubic feet of air per minute.

**OIL SUMP** - The first stage of oil separation from compressed air. Also serves as reservoir area for compressor lubricant and sometimes referred to as the receiver tank.

**PSI** - Refers to the operating pressure the system is set up at, expressed as pounds per square inch.

**SAFETY VALVE** - A valve located on the oil sump which opens in case of excessive pressure. Sometimes referred to as the pop-off or pressure relief valve.

## DESCRIPTION OF COMPONENTS

### COMPRESSOR ASSEMBLY

The BOSS INDUSTRIES compressor assembly is a positive displacement, oil flooded, rotary screw type unit employing one stage of compression to achieve the desired pressure. Components include a housing (stator), two screws (rotors), bearings, and bearing supports. Power from the engine is transferred to the male rotor through a drive shaft and gears in the gear housing. The female rotor is driven by the male rotor. There are four lobes on the male rotor while the female rotor has five roots.

### PRINCIPLES OF OPERATION

In operation, two helical grooved rotors mesh to compress air. Inlet air is trapped as the male lobes roll down the female grooves, pushing trapped air along, compressing it until it reaches the discharge port in the end of the stator and delivers smooth-flowing, pulse-free air to the receiver.

During the compression cycle, oil is injected into the compressor and serves these purposes:

1. Lubricates the rotating parts and bearings.
2. Serves as a cooling agent for the compressed air.
3. Seals the running clearances.

### LUBRICATION SYSTEM

Oil from the compressor oil sump, at compressor discharge pressure, is directed through the oil filter, cooling system, and to the side of the compressor stator, where it is injected into the compressor. At the same time oil is directed internally to the bearings and shaft seal of the compressor. The oil-laden air is then discharged back into the sump.

### OIL SUMP

Compressed, oil-laden air enters the sump from the compressor. As the oil-laden air enters the sump, most of the oil is separated from the air as it passes through a series of baffles and de-fusion plates. The oil accumulates at the bottom of the sump for recirculation. However, some small droplets of oil remain suspended in the air and are passed on to the Coalescer.



## DESCRIPTION OF COMPONENTS

### SAFETY VALVE

The pop safety valve is set at 175 PSI and is located at the top of the air/oil sump. This valve acts as a backup to protect the system from excessive pressure that might result from a malfunction.

### OIL RETURN LINE

The oil that is removed by the coalescer accumulates at the bottom of the can and is returned through an oil return line leading to the compressor. The oil return line is 1/4 tube and goes to elbow fitting which is located at the compressor.

### MINIMUM PRESSURE ORIFICE

The minimum pressure orifice is located at the outlet of the coalescer head and serves to maintain a minimum discharge pressure of 65 PSIG in operation, which is required to assure adequate compressor lubrication pressure.

### OIL FILTER

The compressor oil filter is the full-flow replaceable element type and has a safety bypass built into it.

### COMPRESSOR COOLING SYSTEM (STANDARD)

The compressor cooling system consists of an oil cooler remote mounted aerodynamically designed cooling pressure or a cooler mounted in front of the truck's radiator. Oil temperature is controlled by a thermal switch or a valve located down stream of the oil filter. The switch or valve maintains compressor oil temperatures in the range of 160° - 200° F.

Alternate oil cooling will incorporate an oil thermal valve to mix the discharge oil leaving the oil filter directing hot oil over 180degrees to the cooling unit then to the compressor injection port. Oil not yet up to 180 degrees will be directed back the the compressor injection port until it reaches 180 degrees F.

## DESCRIPTION OF COMPONENTS

### INSTRUMENTATION

#### COMPRESSOR DISCHARGE AIR/OIL TEMPERATURE SWITCH

This normally closed temperature switch, which is located in the oil filter inlet piping, opens a desired safety circuit when the compressor air discharge temperature exceeds 240 degrees F. The switch ensures safety shutdown or indication in case of excessive operating temperatures, preventing compressor damage.

#### AUTOMATIC BLOW DOWN VALVE

There is one blow down valve in the compressor system. It is located at the downstream side of the coalescer head and will automatically bleed the sump to zero pressure when the compressor is disengaged. Blow down time interval takes between 30 to 60 seconds.

### CONTROL SYSTEM

The prime component of the compressor control system is the compressor inlet valve. The control system is designed to match air supply to air demand and to prevent excessive discharge pressure when compressor is at idle. Control of air delivery is accomplished by the inlet valve regulation and modulation as directed by the discharge pressure regulator.

#### DISCHARGE PRESSURE REGULATOR VALVE

This valve, located on the coalescer head is used to set the desired discharge pressure within the operating pressure range. Turning the regulator screw clockwise increases the working pressure, a counterclockwise movement of the screw reduces the working pressure. This system has a maximum operating pressure of 125 PSI.

***NOTE: Most air tools operating pressure range is between 90 and 125 psi. Operating above the tools recommended pressures will decrease the life of the tool. Higher operating pressure can also over torque nut and bolts fatiguing the fastener and mating parts. Strictly adhere to tool operating pressures and torque standards set forth by the tool manufacturer and the specifications of the equipment that work is being performed on.***

#### INLET VALVE

The compressor inlet valve is a piston operated disc valve that regulates the inlet opening to control capacity and serving as a check valve at shutdown.

## DESCRIPTION OF COMPONENTS

### CONTROL SYSTEM OPERATION

The following discussion explains the operation of the control system from a condition of “no load” to a condition of “full capacity” at working pressure. For the working pressure range of your machine, refer to applicable data in “Specifications”.

The pressure regulator, mounted on the coalescer head, operates as follows:

1. As the demand for air decreases, the receiver pressure rises. When this pressure exceeds the set point of the pressure regulator, the regulator opens sending a secondary pressure signal to the inlet valve. The poppet valve moves towards the valve inlet seat against the force of the modulating spring inside the valve. This regulates the opening area of the inlet valve.
2. If the air demand goes to zero, (service valve closed or air dead headed at tool) the inlet valve will close completely.

## INSPECTION, LUBRICATION, AND MAINTENANCE

This section contains instructions for performing the inspection, lubrication, and maintenance procedures required to maintain the compressor in proper operating condition. The importance of performing the maintenance described herein cannot be over emphasized.

The periodic maintenance procedures to be performed on the equipment covered by this manual are listed below. It should be understood that the intervals between inspections specified are maximum interval. More frequent inspections should be made if the unit is operating in a dusty environment, in high ambient temperature, or in other unusual conditions. A planned program of periodic inspection and maintenance will help avoid premature failure and costly repairs. Daily visual inspections should become a routine.

The LUBRICATION AND MAINTENANCE CHART lists serviceable items on this compressor package. The items are listed according to their frequency of maintenance, followed by those items which need only "As Required" maintenance.

The maintenance time intervals are expressed in hours. The hourmeter shows the total number of hours your compressor has run. Use the hourmeter readings for determining your maintenance schedules. Perform the maintenance at multiple intervals of the hours shown. For example, when the hourmeter shows "100" on the dial, all items listed under "EVERY 10 HOURS" should be serviced for the tenth time, and all items under "EVERY 50 HOURS" should be serviced for the second time, and so on.

### DANGER

**COMPRESSOR MUST BE SHUT DOWN AND COMPLETELY RELIEVED OF PRESSURE PRIOR TO CHECKING FLUID LEVELS. OPEN SERVICE VALVE TO ENSURE RELIEF OF SYSTEM AIR PRESSURE. FAILURE TO COMPLY WITH THIS WARNING MAY CAUSE DAMAGE TO PROPERTY AND SERIOUS BODILY HARM.**

## LUBRICATION AND MAINTENANCE CHART

INTERVAL	ACTION
PERIODICALLY DURING OPERATION	1. Observe all gauge reading. Note any change from the normal reading and determine the cause. Have necessary repairs made. (NOTE: "NORMAL" is the usual gauge reading when operating at similar conditions on a day to day operation.)
EVERY 10 HOURS OR DAILY	1. Check the compressor oil level. 2. Check air filter. 3. Check for oil and air leaks. 4. Check safety circuit switches.
EVERY 25 HOURS OR MONTHLY	1. Drain water from compressor oil.
EVERY 500 HOURS OR 6 MONTHS	1. Change compressor oil and oil filter. 2. Check compressor shaft seal for leakage. 3. Check air filter piping, fittings and clamps. 4. Check compressor supports. 5. Install new air filter element. (Shorter interval may be necessary under dusty conditions.) 6. Check sump safety valve.
PERIODICALLY OR AS REQUIRED	1. Inspect and clean air filter element. 3. Inspect and clean oil cooler fins.

NOTE: Compressor oil and filter is to be changed after the first 50 hours of operation. After this, normal intervals are to be followed.

## LUBRICANT RECOMMENDATIONS

### WARNING

**IT IS IMPORTANT THAT THE COMPRESSOR OIL BE OF A RECOMMENDED TYPE AND THAT THIS OIL AS WELL AS THE AIR FILTER, OIL FILTER, AND COALESCER ELEMENTS BE INSPECTED AND REPLACED AS STATED IN THIS MANUAL.**

**THE COMBINATION OF A COALESCER ELEMENT LOADED WITH DIRT AND OXIDIZED OIL PRODUCTS TOGETHER WITH INCREASED AIR VELOCITY AS A RESULT OF THIS CLOGGED CONDITION MAY PRODUCE A CRITICAL POINT WHILE THE MACHINE IS IN OPERATION WHERE IGNITION CAN TAKE PLACE AND COULD CAUSE A FIRE IN THE OIL SUMP.**

**FAILURE TO COMPLY WITH THIS WARNING MAY CAUSE DAMAGE TO PROPERTY AND SERIOUS BODILY HARM.**

The following are general characteristics for a rotary screw lubricant. Due to the impossibility of establishing limits on all physical and chemical properties of lubricants which can affect their performance in the compressor over a broad range of environmental influences, the responsibility for recommending and consistently furnishing a suitable heavy duty lubricant must rest with the individual supplier if they choose not to use the recommended BOSS INDUSTRIES rotary screw lubricant. The lubricant supplier's recommendation must, therefore, be based upon not only the following general characteristics, but also upon his own knowledge of the suitability of the recommended lubricant in helical screw type air compressors operating in the particular environment involved.

### CAUTION

**MIXING DIFFERENT TYPES OR BRANDS OF LUBRICANTS IS NOT RECOMMENDED DUE TO THE POSSIBILITY OF A DILUTION OF THE ADDITIVES OR A REACTION BETWEEN ADDITIVES OF DIFFERENT TYPES.**

## LUBRICANT RECOMMENDATIONS

### LUBRICANT CHARACTERISTICS

1. Flash point 400°F minimum.
2. Pour point -40°F.
3. Contains rust and corrosion inhibitors.
4. Contains foam suppressors.
5. Contains oxidation stabilizer.

### NOTE

**DUE TO ENVIRONMENTAL FACTORS THE USEFUL LIFE OF ALL "EXTENDED LIFE" LUBRICANTS MAY BE SHORTER THAN QUOTED BY THE LUBRICANT SUPPLIER. BOSS INDUSTRIES ENCOURAGES THE USER TO CLOSELY MONITOR THE LUBRICANT CONDITION AND TO PARTICIPATE IN AN OIL ANALYSIS PROGRAM WITH THE SUPPLIER.**

### NOTE

**NO LUBRICANT, HOWEVER GOOD AND/OR EXPENSIVE, CAN REPLACE PROPER MAINTENANCE AND ATTENTION. SELECT AND USE IT WISELY.**

## MAINTENANCE

### COMPRESSOR OIL SUMP FILL, LEVEL, AND DRAIN

Before adding or changing compressor oil make sure that the sump is completely relieved of pressure. Oil is added at the fill cap on the side of the receiver/sump. A drain plug is provided at the bottom of the sump. The proper oil level, when unit is shut down and has had time to settle, is at the midpoint of the oil sightglass. The truck must be level when checking the oil. **DO NOT OVERFILL.** The oil sump capacity is given in “Compressor Specifications”.

### DANGER

**DO NOT ATTEMPT TO DRAIN CONDENSATE, REMOVE THE OIL LEVEL FILL PLUG, OR BREAK ANY CONNECTION IN THE AIR OR OIL SYSTEM WITHOUT SHUTTING OFF COMPRESSOR AND MANUALLY RELIEVING PRESSURE FROM THE SUMP. FAILURE TO COMPLY WITH THIS WARNING MAY CAUSE DAMAGE TO PROPERTY AND SERIOUS BODILY HARM.**

### AIR INTAKE FILTER

The air intake filter is a heavy-duty two-stage dry type high efficiency filter designed to protect the compressor from dust and foreign objects.

The filter is equipped with an evacuator cup for continuous dust ejection while operating and when stopped.

Frequency of maintenance of the filter depends on dust conditions at the operating site. The filter element must be serviced when clogged.



## MAINTENANCE

### OIL FILTER

The compressor oil filter is a spin-on, throw away type.

To replace filter proceed as follows:

1. Make sure system pressure is relieved.
2. Remove filter by unscrewing from filter head (turn counterclockwise by hand viewing from bottom) and discard.
3. Install a new filter by applying a little oil to the seal and then screw the filter on by hand (turning it clockwise until hand tight, plus one - third turn viewing from bottom). Do not use tools to tighten the filter.
4. Check for leaks in operation.

### WARNING

**DO NOT SUBSTITUTE ELEMENT. USE ONLY A GENUINE BOSS INDUSTRIES REPLACEMENT ELEMENT. THIS ELEMENT IS RATED AT 200 PSI WORKING PRESSURE. USE OF ANY OTHER ELEMENT MAY BE HAZARDOUS AND COULD IMPAIR THE PERFORMANCE AND RELIABILITY OF THE COMPRESSOR, POSSIBLY VOIDING THE WARRANTY AND/OR RESULTING IN DAMAGE TO PROPERTY AND SERIOUS BODILY HARM.**

### OIL COOLER

The interior of the oil cooler should be cleaned when the pressure drop across it at full flow exceeds 25 PSI. The following procedure has been recommended by the vendor who supplies the cooler:

1. Remove cooler.
2. Circulate a suitable solvent to dissolve and remove varnish and sludge.
3. Flush generously with BOSS INDUSTRIES compressor lubricant.
4. After cooler is reinstalled and compressor is filled with fresh oil, change compressor oil after 50 hours of normal operation.

### OIL RETURN LINE

This line originates at the top of the air/oil coalescer and flows through a special 1/4 tube elbow located at the air-end. This elbow incorporates an oil return line check valve stopping the flow of oil into the coalescer at shutdown.

## TROUBLESHOOTING

### SUMP PRESSURE DOES NOT BLOW DOWN

If after the compressor is shutdown, pressure does not automatically blow down, check for:

1. Automatic blow down valve may be inoperative at coalescer head.
2. Blockage in air line from side of inlet valve to blow down valve.
3. Muffler at blow down clogged.

### OIL CONSUMPTION

Abnormal oil consumption or oil in service line, check for the following:

1. Over filling of oil sump.
2. Leaking oil lines or oil cooler.
3. Plugged oil return line: check entire line, to the compressor.
4. Compressor shaft seal leakage.
5. Discharge pressure below 65 PSI or above 150 PSI.

### HIGH COMPRESSOR DISCHARGE TEMPERATURE

1. Check compressor oil level. Add oil if required (see Section for oil specifications).
2. Check thermal valve operation. (Front mounting coolers only).
3. Clean outside of oil cooler.
4. Clean oil system (cooler) internally.

## COMPRESSOR OPERATION

Before starting the compressor, read this section thoroughly. Familiarize yourself with the controls and indicators, their purpose, location, and use.

<b>CONTROL OR INDICATOR</b>	<b>PURPOSE</b>
FLUID LEVEL SIGHTGLASS	Indicates fluid level in the sump. Proper level should fill half the glass. Check this level when the compressor is disengaged and the vehicle is parked on level ground.
PRESSURE RELIEF VALVE	Vents sump pressure to the atmosphere if the pressure inside the sump exceeds 175 PSI.
COMPRESSOR INLET CONTROL VALVE	Regulates the amount of air intake in accordance with the amount of compressed air being used. Isolates fluid in compressor unit on shutdown.
PRESSURE REGULATING VALVE	Senses air pressure from sump to provide automatic regulation of the compressor inlet control valve and load controller.
BLOW DOWN VALVE	Coalescer head blow down valve vents the sump pressure to the atmosphere at shut down.
MINIMUM PRESSURE ORIFICE	Restricts air flow to balance sump and service air pressure. Assures a minimum of 65 PSI to maintain compressor lubrication.
RETURN LINE CHECK VALVE	Ensures that the back flow to coalescer element does not occur during shut down.

## COMPRESSOR OPERATION

### OPERATING CONDITIONS

The following conditions should exist for maximum performance of the compressor. The compressor should be as close to level as possible when operating. The compressor will operate on a 15 degree sideward and lengthwise tilt without any adverse problems. Fluid carry over and/or oil starvation may occur if operated beyond this tilt.

### NOTE

**IF THE COMPRESSOR IS BEING USED TO POWER SANDBLASTING EQUIPMENT, OR AN AIR STORAGE TANK, USE A CHECK VALVE DIRECTLY AFTER THE MINIMUM PRESSURE ORIFICE TO PREVENT BACKFLOW INTO THE SUMP. THIS CHECK VALVE SHOULD HAVE A MAXIMUM PRESSURE DROP RATING OF 2 PSIG (13.78kPa) OPERATING AND A CAPACITY RATING EQUAL TO THE COMPRESSOR.**

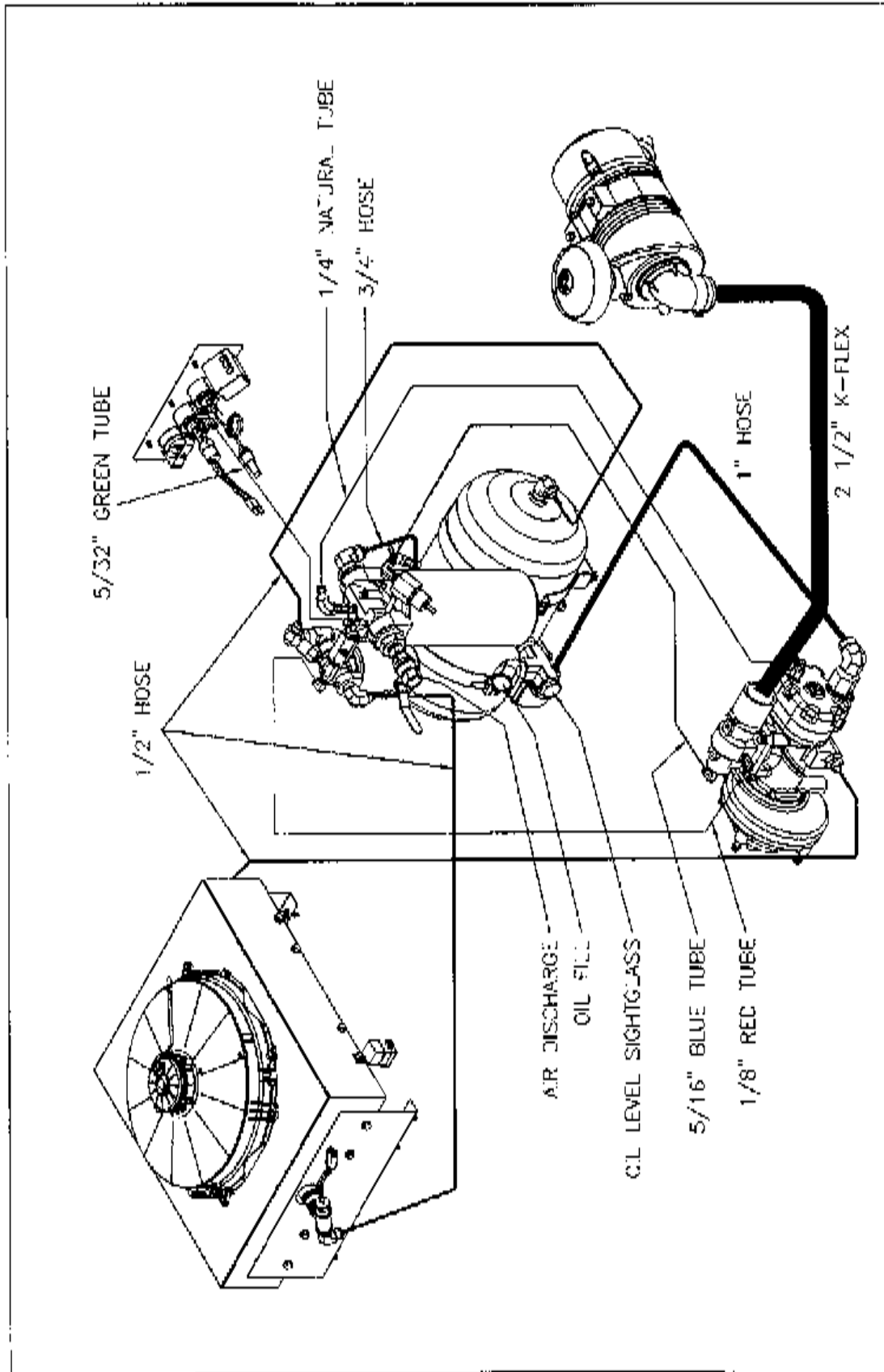
### NOTE

**THE COMPRESSOR SERVICE VALVE SHOULD BE RELOCATED TO THE HOSE REEL INLET OR BE THE CUSTOMERS AIR CONNECTION PORT WHEN A HOSE REEL IS NOT USED. TYPICAL PLUMBING FROM MINIMUM PRESSURE ORIFICE SHOULD FLOW IN THE FOLLOWING ORDER:**

- 1. MINIMUM PRESSURE ORIFICE.**
- 2. CHECK VALVE.**
- 3. AIR TANK (WHEN USED).**
- 4. OSHA VALVE.**
- 5. SERVICE VALVE.**
- 6. MOISTURE TRAP/GAUGE/OILER COMBINATION**
- 7. HOSE REEL (WHEN USED).**

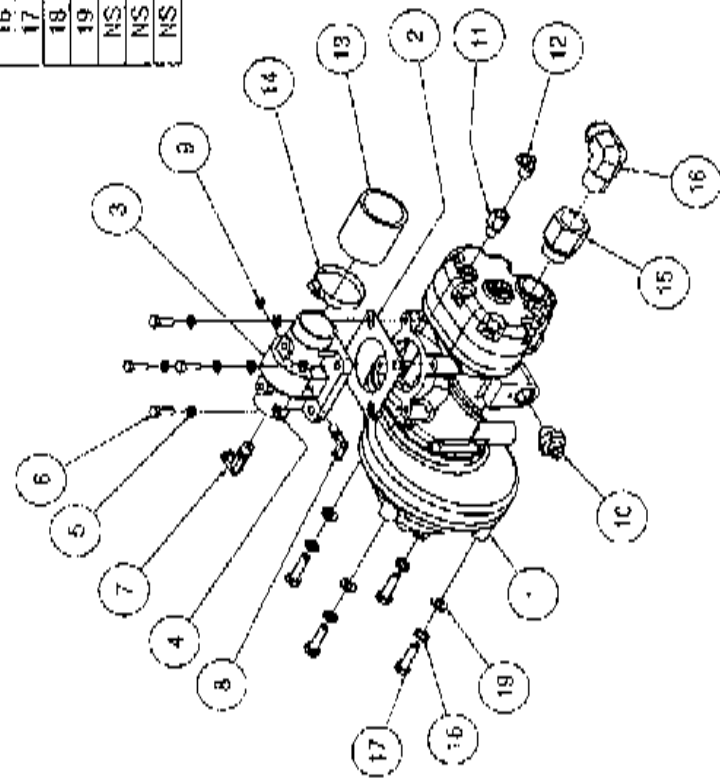
## **PARTS AND ILLUSTRATION SECTION**

# AIR/OIL SCHEMATIC



DO NOT SCALE		DATE	BY	REV.	APPROVED BY
THIS DRAWING IS THE PROPERTY OF BOSS INDUSTRIES, INC. IT IS TO BE KEPT IN CONFIDENTIALITY AND NOT REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, INCLUDING PHOTOCOPYING, RECORDING, OR BY ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM.		10/20/71	WJL	1	WJL
BOSS INDUSTRIES, INC. 1101 W. 11TH ST. OKLAHOMA CITY, OKLA. 73106		BOSS INDUSTRIES, INC. 1101 W. 11TH ST. OKLAHOMA CITY, OKLA. 73106			
AIR/OIL SCHEMATIC		AIR/OIL SCHEMATIC			
CHROMEWORKS		CHROMEWORKS			
REV. 1		REV. 1			
0		0			
1/2"		1/2"			
1/2"		1/2"			

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	301709-369	AIR END, SCABG 85/23 9.69" RATIO
2	1	302467	GASKET, 0.092 INLE VALVE 1875 TO ADAPTER
3	1	302203	VALVE, INLET 30-90 AC 2.030
4	4	938908-180	WASHER, FJAT 8MM
5	4	938808-200	WASHER, LOC 8MM
6	4	929208-250	BOLT, HEX GR10.9 8MM X 25MM
7	1	987305-025M	ELBOW, 1/4 MNPT X 5/16 TUBE 200PSI 250 DEG W/ HOLE
8	1	987302-012	ELBOW, 1/8 MNPT X 1/8 TUBE 200PSI 250C DEG
9	1	902915-005	PLUG, PIPE 1/8 RECESSED ZINC
10	1	976708-050	CONNECTOR, 1/2 MJC X 1/2 MBSPP
11	1	976804-025	ADAPTER, 1/4 MBSPP X 1/4 FNPT
12	1	304720	VALVE, CHECK ELBOW 1/4 TUBE X 1/4 FNPT
13	1	306040	ADAPTER, RUBBER 2 1/2 TG 2
14	1	301786-250	CLAMP, AIR INLET 2 1/2" K/FLEX
15	1	970816-100	ADAPTER, 1 MBSPP M X 1 FNPT
16	1	960216-100	ELBOW, HYD 1 MJC X 1 MNPT
17	4	929210-350	BOLT, HEX GR10.9 10MM X 35MM
18	4	938816-220	WASHER, LOC 10MM
19	4	938910-200	WASHER, FLAT 10MM
NS	1	307914	COUPLING, FLEX SCABG IN/SAE #5 HOUSING ADAPTER
NS	8	938005-078	WASHER, LOC GR5 5/16
NS	8	929105-100	BOLT, HEX GR5 5/16-18 X 1



**BOSCH**  
 BOSCH INDUSTRIES  
 137 GENESIS PK  
 LA BOUTE, LA 70052

COMPRESSOR THROTTLING 100 ENGINE DRIVE

SCALE: 1:1

DATE: 10/20/7

DRAWN BY: C. L. A.

CHECKED BY: C. L. A.

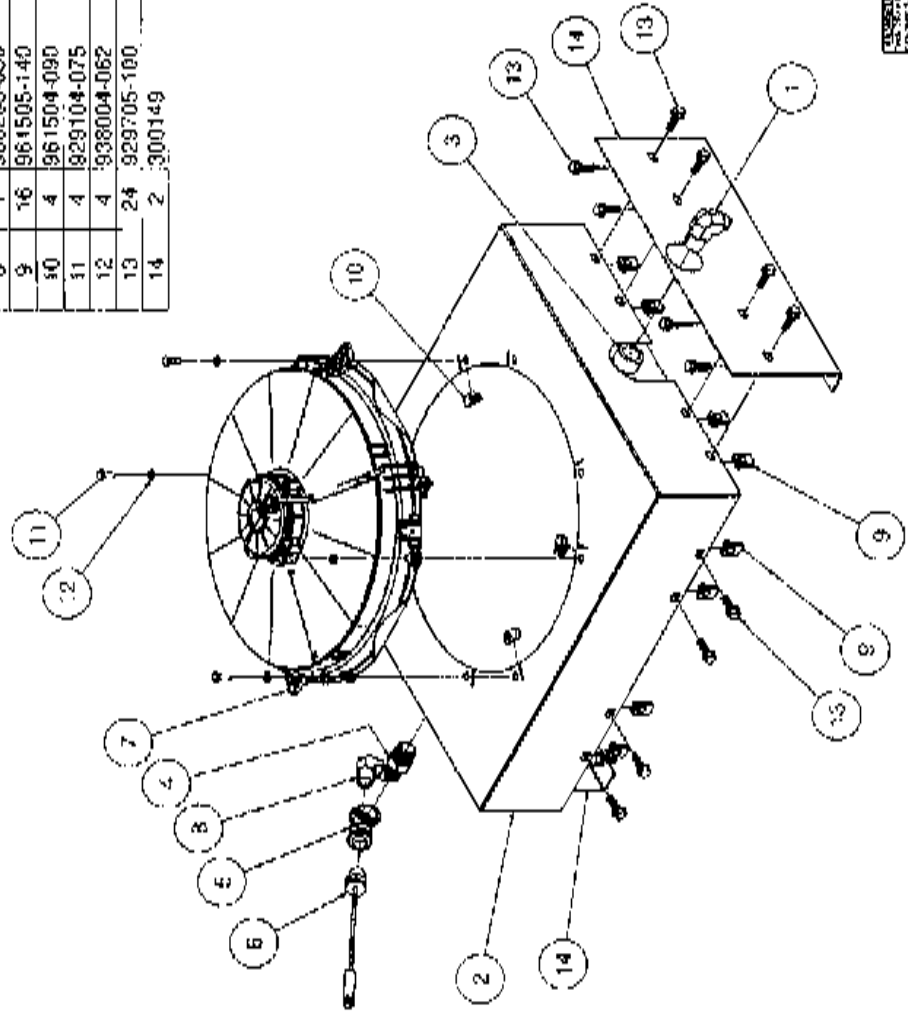
APPROVED BY: C. L. A.

SHEET 1 OF 1





ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	950202-075	ELBOW, 1/2 JIC X 3/4 MNPT
2	1	506159	SHROUD, OIL CLR 80200 AHBI 2007
3	1	500314	COOLER, OIL 18.52
4	1	951612-050	NIPPI F, HYD HEX RED 3/4 X 1/2
5	1	932415-020	TEE, PIPE 1/2 GAL 150PSI
6	1	302865	SENSOR, TEMP 75 F NO WWP COMM
7	1	307188	FAIR ASSY, S16C 12V 194BCFM
8	1	960208-050	ELBOW, 1/2 JIC X 1/2 MNPT
9	16	961505-140	NUT, TINNERMAN 5/16-18
10	4	961504-080	NUT, TINNERMAN 1/4-20
11	4	929104-075	BOLT, HEX GR5 1/4-20 X 3/4
12	4	938004-062	WASHER, LOC GR5 1/4
13	24	929705-100	BOLT, WHIZ_LOCK GR5 5/16-18 X 1
14	2	300149	BRACKET, OIL COOLER VENTURI 'B



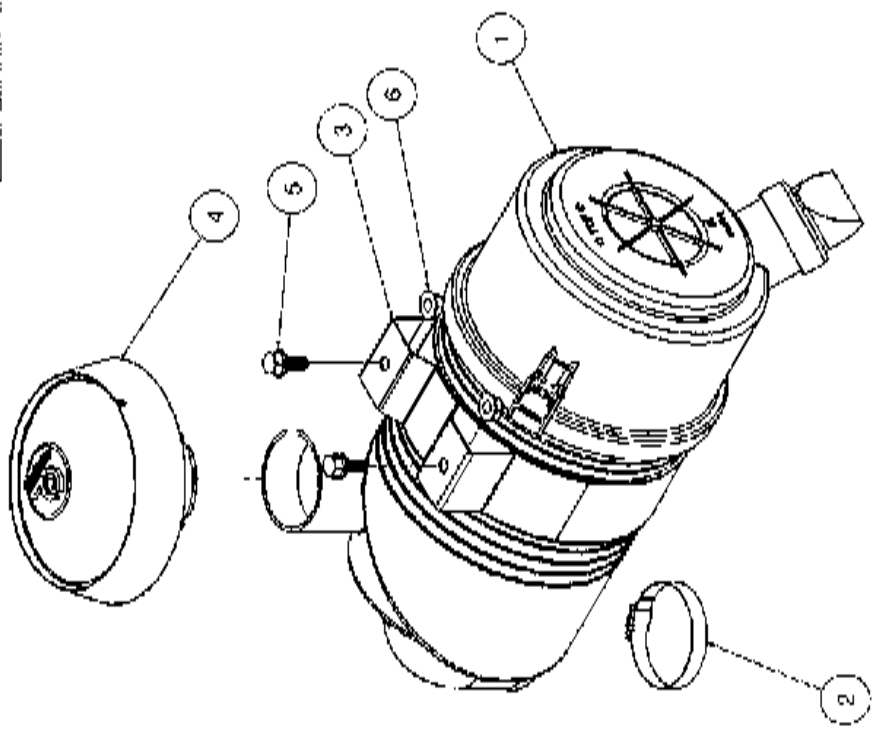
**ROSS**  
 CROSS-HOLDS-485  
 1261 REESES DR  
 AUSTIN, TX 78746

DESCRIPTION  
 COOLER SYS THOMP-24K5 100  
 ENGINE DRIVE

DATE 5/27/13 10:50:00  
 BY E. J. J. 300149  
 PARTS FILE: 300149

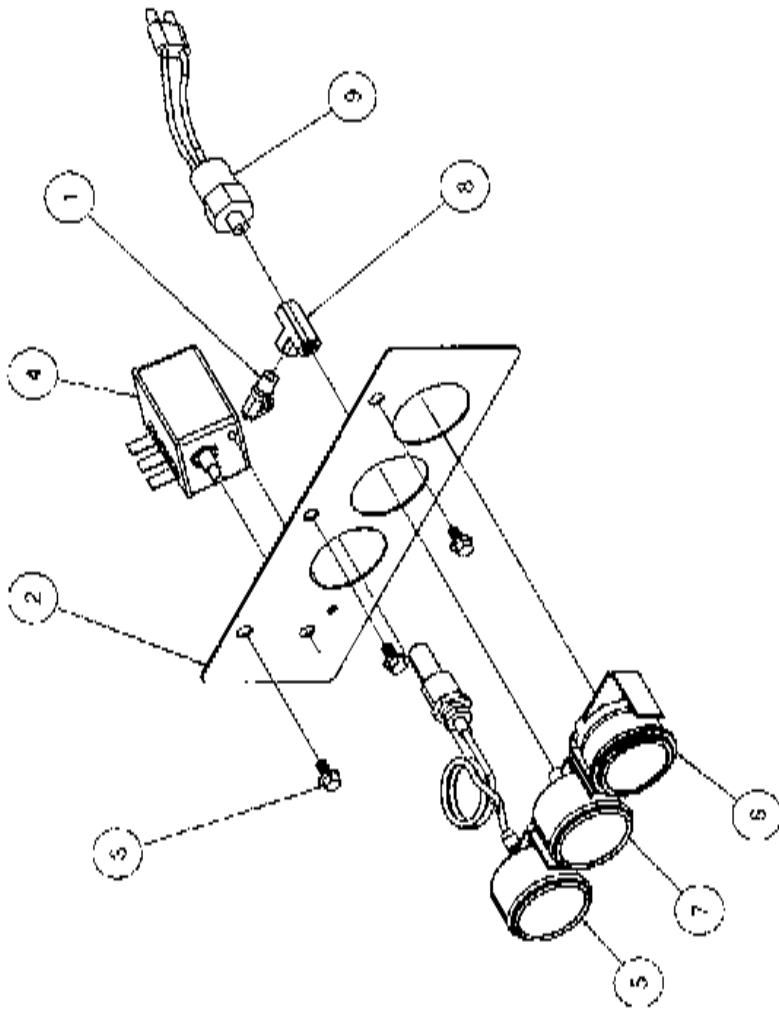
REVISIONS  
 1. 5/27/13 E. J. J. 300149  
 2. 5/27/13 E. J. J. 300149

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	3010687	ASSY, AIR FILTER, 6.8 90°
2	1	301786-250	CLAMP, AIR INLET 2 1/2" KFLEX
3	1	3010680	BAND, AIR FILTER 5.8 I.D., FBI
4	1	301079	CAP, AIR FILTER 6.8 IBI, FBI
5	2	928705-075	BOLT, WHIZLOCK GR5.5:6-18 X 3/4
6	2	925305-283	NUT, WHIZ LOCK 5" 6-18



<b>BOSS</b> BOSS INDUSTRIES 1701 GARDNER DR. LA PORTE, IN 46320	
MANUFACTURED BY BOSS INDUSTRIES 1701 GARDNER DR. LA PORTE, IN 46320	TERMPROLOGY AIR FILTERS, THERMO-CORPS-90 5400 S. W. 11th St. Miami, FL 33149
PART NUMBER 3010687	PART NAME AIR FILTER ASSEMBLY
QUANTITY 1	UNIT OF MEASURE EACH
DATE 10/1/80	DRAWING NO. 10000000
DESIGNED BY J. J. HARRIS	CHECKED BY J. J. HARRIS
DRAWN BY J. J. HARRIS	APPROVED BY J. J. HARRIS
DATE 10/1/80	SCALE 1:1
SHEET NO. 1	TOTAL SHEETS 1

ISSU	QTY	PART NUMBER	DESCRIPTION
1	1	9817325-012	ELBOW, 3/8 MNPT X 5/32 TUBE 200PSI 250 DEG
2	1	3061175	BRACKET, 80200 GALGE
3	3	929704-050	BO-LT, W/IZLOCK GR5 14-23 X .72
4	1	360079	SWITCH, SF-UTDCWM 117
5	1	300878-004	SWITCH-GALGE, MP 4 T-250
6	1	300074	GAUGE, HOURMETER
7	1	300075	SWITCH-GALGE, PRESSURE
8	1	960602-012	TEE, HYD F X F X F 1/8 300PSI
9	1	301422	SWITCH, PRESS NO 20 PSI W
NS	1	309020	HARNES, THORWORKS 10C ENGINE-DR VE



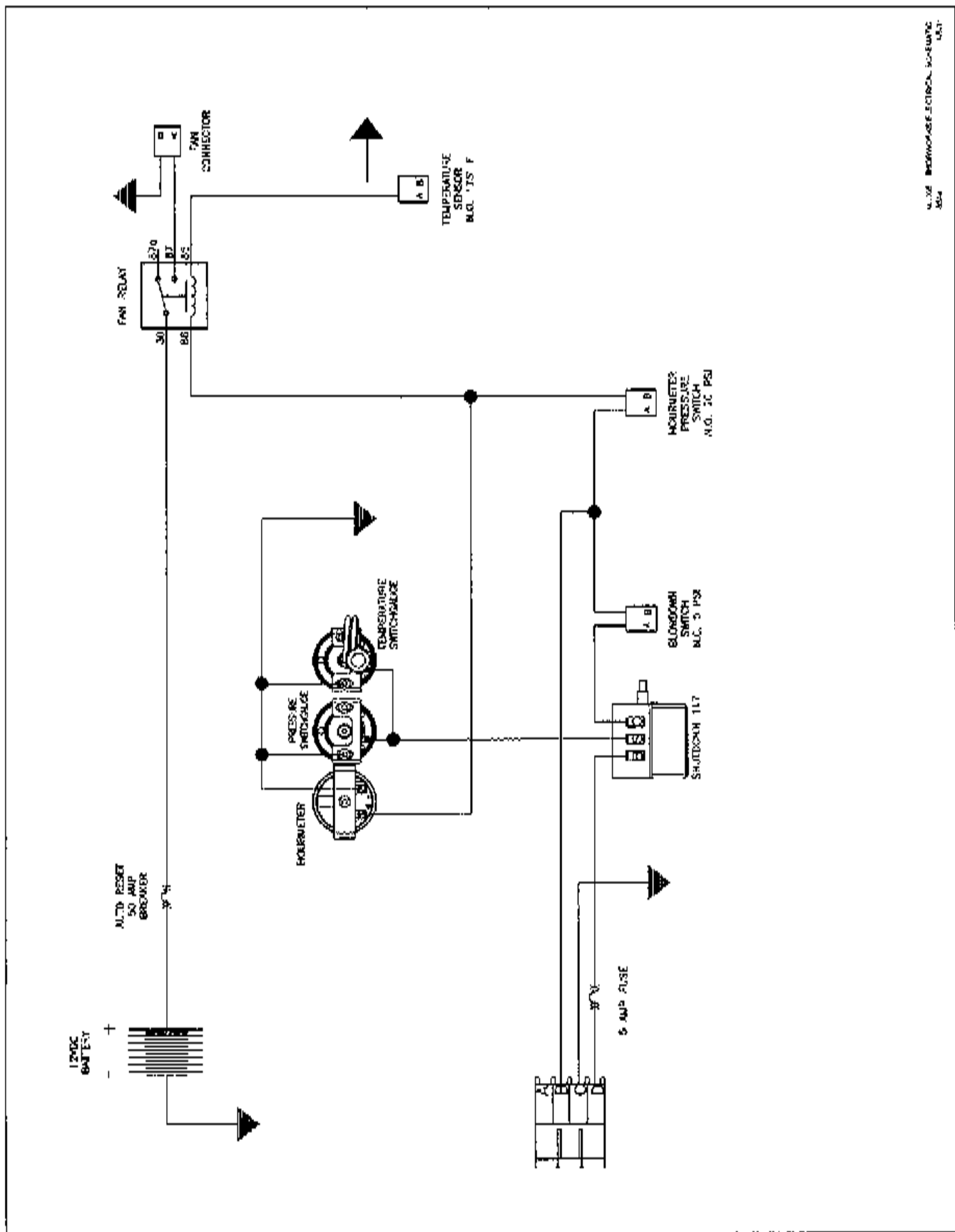
**DOSS INDUSTRIES**  
 JARI GENES DR.  
 I.A. 41017E. 81 5570

ELECT. SCS. 1-400-700-0000 MO. FINEME-IRMS E  
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PART NO. 309020  
 REV. 00015  
 DATE 01/15/01

DRAWN BY: JARI GENES  
 CHECKED BY: JARI GENES  
 APPROVED BY: JARI GENES

SHEET 1 OF 1



W. ZE BRIDGE-ELECTRICAL SOURCE UNIT

## RECOMMENDED SPARE PARTS

PART NUMBER	DESCRIPTION
300005	OIL FILTER ELEMENT
301082	AIR FILTER ELEMENT
307471	REGULATOR REPAIR KIT
307092	SHAFT SEAL REPAIR KIT SCABG
304122	AIR/OIL SEPARATOR ELEMENT