CRAFCO™ INC

AN ERGON COMPANY

BC 220 & BC 220-4

1983

1983 EDITION

BC220 & BC220-4

This manual is furnished with each new CRAFCO Joint & Crack Sealer. The manual will help your machine operators learn to run the sealer properly and understand its mechanical functions for trouble-free operation.

Your CRAFCO BC220 or BC220-4 is designed to give excellent service and save maintenance expense. However, as with all specially engineered equipment, you can get best results at minimum costs if:

(1) You operate your machine as instructed in this manual, and

(2) Maintain your machine regularly as stated in this manual.

Manufactured under Patent Nos. 3610588, 4159877, DES257149, CANADA 1098114 other patents pending.

WARNING: The Engine Exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects or other reproductive harm. Operate in well ventilated area only. Engine Exhaust is deadly.

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SAFETY PRECAUTIONS

High operating temperatures of Sealant & Machine require protective clothing and gloves be worn by operator.

Always wear eye and ear protection.

Observe all CAUTION & WARNING signs posted on machine.

Avoid the entrance of water into any part of the machine. Water will displace heat transfer oil or sealant, which could be hazardous to personnel surrounding the machine when it reaches operating temperatures.

Avoid bodily contact with hot sealant material or heat transfer oil, serious burns may result.

Read Operator Manual thoroughly before operating machine.

Make sure operator is familiar with machine operation.

Do not operate in closed building or confined areas.

Shut down Burners & Engine prior to refueling.

When adding solid material to Sealant tank, stop Auger, lift lid, lower material into tank and close lid before restarting Auger. Hot material could splash and cause serious burns if procedure is not followed.

Keep hands, feet and clothing away from all moving parts.

Always keep a fire extinguisher near the unit. Maintain extinguisher properly and be familiar with its use.

Do not exceed 500^{o} F. for heat transfer oil temperature.

Do not overfill heat transfer oil level or spillage will occur when machine reaches operating temperature.

Use only recommended heat transfer oil and change at recommended intervals.

Follow operating instructions for starting and shut-down of Burners and Plot Light.

Calibrate temperature control prior to initial operation and each 50 hours of operation.

Replace any hoses which show signs of wear, fraying or splitting. Be sure all fittings and joints are tight and leakproof.

Precaution is the best insurance against accidents.

The **CRAFCO BC220 (BC220-4)** should not be left unattended with propane burners or pilot lit. Sealant should be heated by use of electric heating elements, when left unattended.

CRAFCO, INC. assumes no Liability for an accident or injury incurred through improper use of the Machine.

CRAFCO CRACK SEALER
MODELS BC220 AND BC220-4
LIMITED WARRANTY

CRAFCO, Inc. warrants to the original purchaser only, that each new CRAFCO machine, *excluding* the hydraulic system, material pump, material applicator hose, and heating system, will be free from defects in material and workmanship for a period of one (1) year from the date of delivery. Integral units such as gasoline engines, electric motors, transmissiions, etc., are subject to the warranties issued by the manufacturers of such units.

The responsibility of CRAFCO under this warranty is limited to replacement or repair of defective parts at CRAFCO's Chandler, Arizona factory, or at a point designated by it, of such parts as shall appear to CRAFCO, upon inspection at such point, to have been defective in material or workmanship. The labor covered by this warranty include *only* that labor which is required to repair the defective part itself, and *not* that labor required to gain access to the part.

CRAFCO, Inc. shall only be liable when the equipment is used in compliance with those directions specified in the manufacturer's instructions.

The warranty provided herein extends only to the repair and/or replacement of those components of the equipment covered above, and does not extend to incidental or consequential damages incurred as a consequence of any defects covered by this warranty.

This warranty shall not apply to any machine or parts altered and modified without CRAFCO's consent, nor shall it apply to normal wear and tear or when misuse, negligence or accident are evident, or when machines have been operated at speeds or loads beyond factory-rated capacities or specifications.

CRAFCO, Inc. specifically disavows any other representation, warranty, or liability related to the condition or use of the product.

WARRANTY CLAIM INSTRUCTIONS

Please follow the instructions stated below when calling in a Warranty Claim. Failure to follow these procedures will cause the Warranty Claim to be voided.

(1) Indicate To CRAFCO's Customer Service Representative by telephone or letter that the order being placed is a *Warranty Claim*.

(2) Indicate to the CRAFCO Customer Service Representative the type of equipment under warranty, serial number and a brief description of the warranty defect. A replacement part will be shipped immediately F.O.B. Chandler, Arizona and invoiced.

(3) Return the defective part to CRAFCO within fifteen (15) days of the date the claim was called in. Indicate on shipper, packing slip or by letter the model number and serial number of the machine from which the defect is being claimed along with the part being returned. If the defective part is not returned to CRAFCO within the fifteen (15) day period or if the defect is determined by *CRAFCO*, Inc. to be due to normal wear and tear or misuse, the claim will be voided. The customer will be notified within ten (10) days of disposition of the claim. If the failure was caused by a defect in material or workmanship, a credit will be issued.

If you have any additional questions reguarding warranty repairs and parts, please do not hesitate to call toll free 1-800 528-8242.

SPECIFICATIONS

BC220

Vat Capacity	200 Gallons
Melting Capacity	100 Gallons Per Hour
Heat Transfer Oil Required	65 Gallons at 70° F.
Heat Transfer Oil Tank Capacity	80 Gallons at 500° F.
Tank Construction	Double Boiler Type
Tank Opening Size	16" x 24"
Maximum Heat Input	Vapor Burners 250,000 BTU's each Liquid Burners 200,000 BTU's each
Burner and Temperature Control	Automatic - Fail Safe
Heat Transfer Oil Specifications	Flash Point - 575° F. Fire Point - 600° F.
Engine	Opposed 2 cyclinder 20 HP Onan
Drive Mechanism	Complete hydraulic offering infinite speed control in forward and reverse.
Agitation	Reversed rotary auger action
Type of Pump	Roper 2" hot asphalt type
Tires (2)	9.50 x 16.5 LT - 3,150 lbs. capacity each.
Brakes	2" x 12" electric
Axle	5,200 lbs. capacity
Weight (Dry)	3,500 lbs.

BC 220-4

Vat Capacity	400 Gallons
Melting Capacity	200 Gallons Per Hour
Heat Transfer Oil Required	130 Gallons at 70° F.
Heat kTransfer Oil Tank Capacity	160 Gallons at 500° F.
Tank Construction	Double Boiler Type
Tank Opening Size	16" x 24"
Maximum Heat Input	Vapor Burners 250,000 BTU's each Liquid Burners 200,000 BTU's each
Burner and Temperature Control	Automatic - Fail Safe
Heat Transfer Oil Specifications	Flash Point - 575° F. Fire Point - 600° F.
Engine	Opposed 2 cyclinder 20 HP Onan
Drive Mechanism	Complete hydraulic offering infinite speed control in forward and reverse.
Agitation	Reversed rotary auger action
Type of Pump	Roper 2" hot asphalt type
Tires (4)	9.50 x 16.5 LT - 3,150 lbs. capacity each
Brakes	2" x 12" electric
Axle (2)	5,200 lbs. capacity
Weight (Dry)	4,400 lbs.

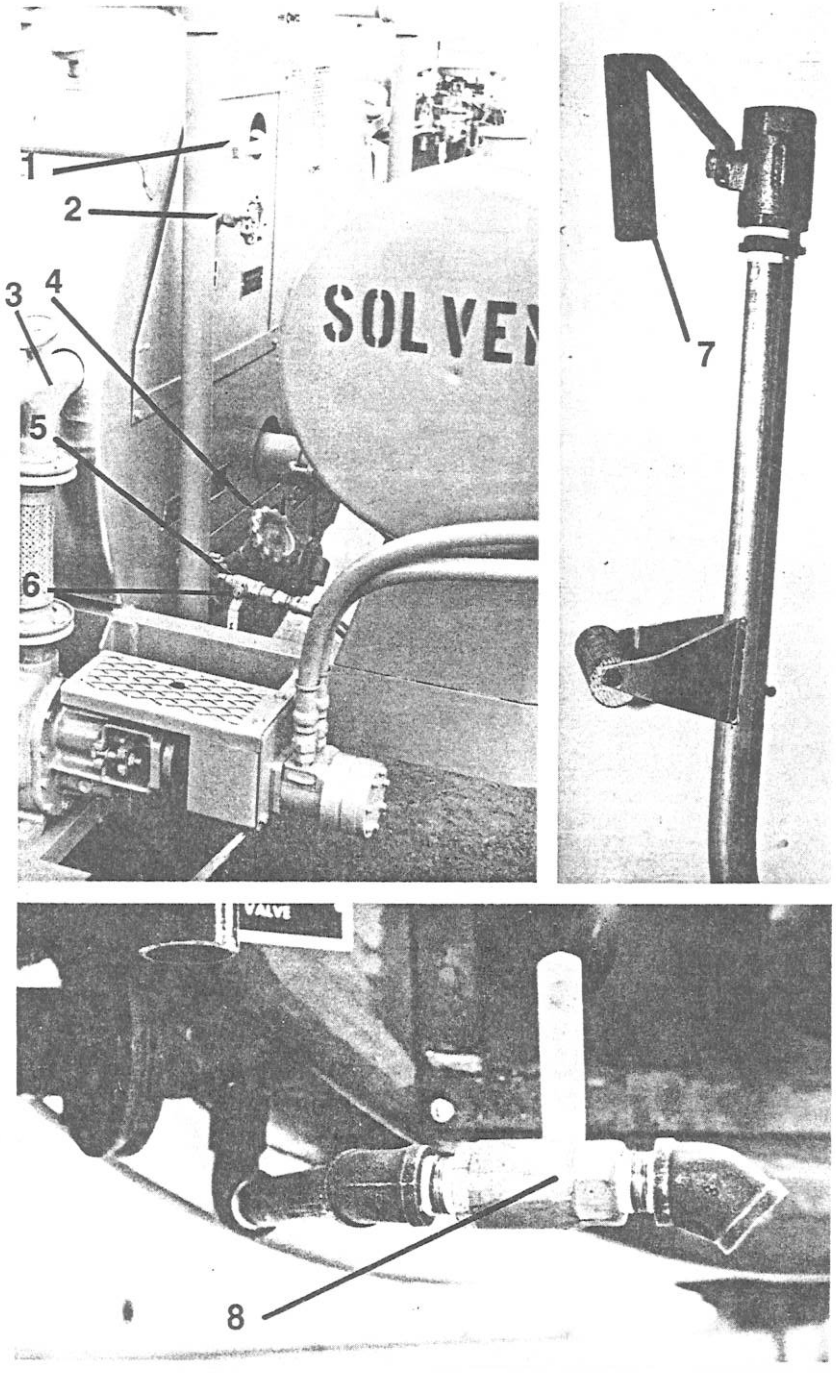


FIGURE 1

OPERATING INSTRUCTIONS

INTRODUCTION

The CRAFCO Joint and Crack Sealer was developed to apply CRAFCO Brand Sealants. However, it will work equally well with all road asphalts and federal specification crack or joint sealants.

1. **Recirculation Valve** - controls flow of sealant returning to material tank.
2. **Applicator Valve** - for rear applicator.
3. **2" Line** - used in loading machine with liquid asphalt material.
4. **Tank Valve** - used to open material tank to pump.
5. **Check Valve** - to prevent sealant from entering solvent tank.
6. **Clean-Out Valve** - for flushing system with solvent after use.
7. **Hand Applicator Valve** - for turning hand applicator off for short periods of time.
8. **Drain Valve** - used to drain solvent from lines after flushing system with solvent.

Auger Control Valve - (2) Fig. 2, controls auger rotation in either direction with off position in middle. Auger is used to agitate sealant material.

Pump Control Valve - (1), Fig. 2, controls pump rotation in either direction with off position in middle. Pump is used to force sealant through the applicator, but can also be used to draw liquid materials into the tank.

Automatic Temperature Control - starts the burners and regulates the temperature of the heat transfer oil. See Figure 3. The automatic temperature control may be set to any desired temperature, *but not to exceed 500° F.* It is necessary to check the calibration of the thermostat before using the machine initially, see page 12 for instructions.

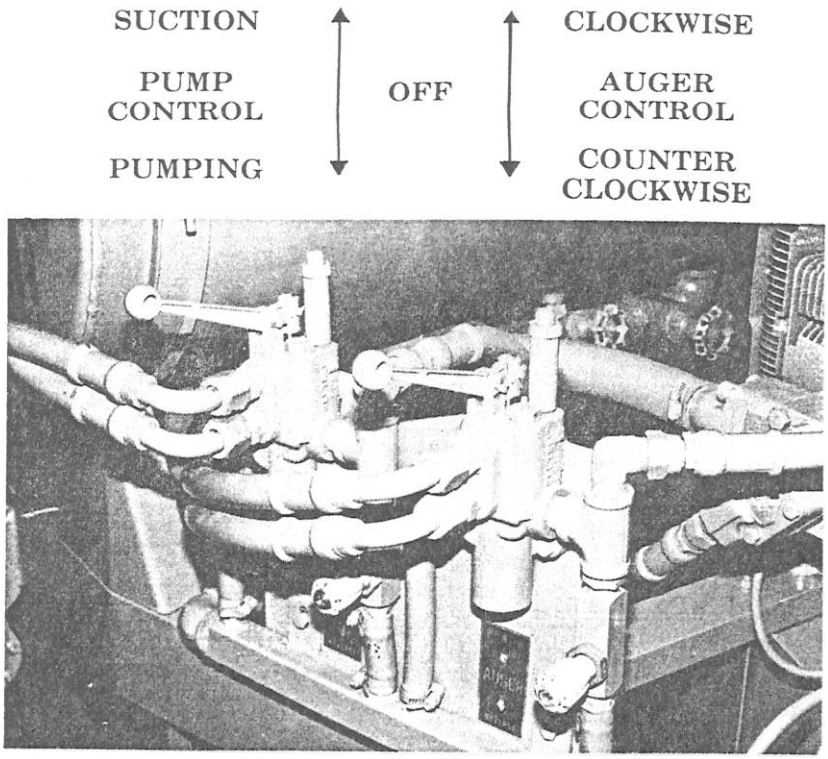


FIGURE 2 — Hydraulic Control Valves

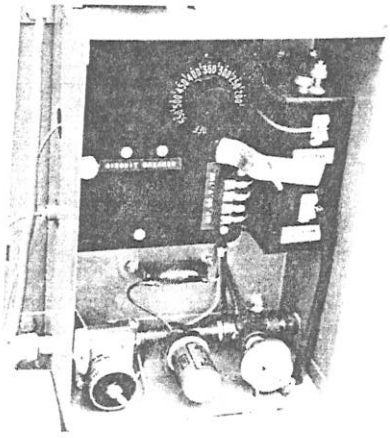


FIGURE 3
Temperature Control

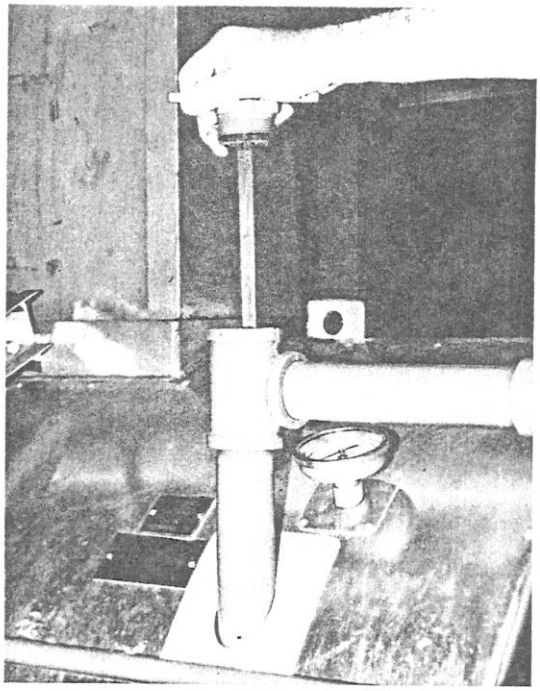


FIGURE 4 — Checking Heat Transfer Oil Supply

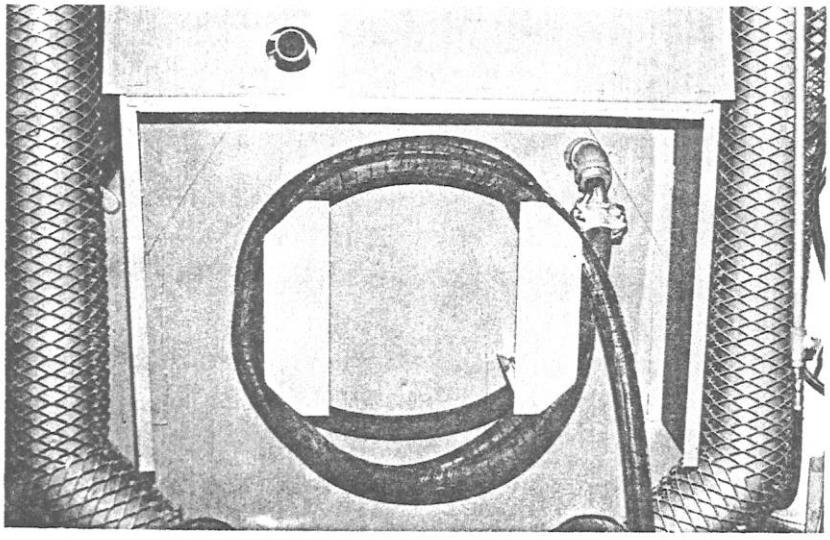


FIGURE 5 — Heating Chamber

PREPARING MACHINE FOR OPERATION

DO NOT operate machine without following these instructions:

1. Fill engine fuel tank with regular grade non-leaded gasoline or diesel fuel according to the type of engine.
2. Fill propane storage tanks.
3. Check engine crankcase oil, refer to Onan Engine section for instructions or engine handbook, if diesel.
4. Check hydraulic oil supply tank. Oil level should be 3" - 5" from top of tank, or at fullmark (ambient temperature if your machine is equipped with dip sticks.
5. Check heat transfer oil supply, refer to figure 4. Check heat transfer oil level at ambient temperature with machine leveled. Oil should be at full mark at 70° F. DO NOT OVERFILL or spillage will occur when machine reaches operating temperature.
6. Check solvent supply. Solvent must be compatible with sealant material being used. Consult manufacturer of sealant for type of solvent recommended.
7. All valves should be in closed position. See Figure 1.
8. Applicator hose can be kept warm and ready for use by storing it in heating chamber before use of machine. See Figure 5. Close heating chamber door after hose has been coiled in heating chamber.

MACHINE START UP

TO START BURNERS

Open burner valves (4), Fig. 7, open L.P.G. cylinder valve (1), Fig. 6, open line ball valve (3), Fig. 7, set pressure regulator to 18 PSI (2), Fig. 6. Pilot (1), Fig. 8, will ignite in 5 to 10 seconds. Set desired temperature required on temperature indicator dial inside control box (5), Fig. 7. Burners (2), Fig. 8, will ignite in 20 to 30 seconds.

CAUTION:

If the pilot does not light in 30 seconds, close line valve before seeking cause of malfunction. (Probable cause - low fuel pressure, spark plug gap too wide or low battery voltage or orifice plugged with foreign material.)

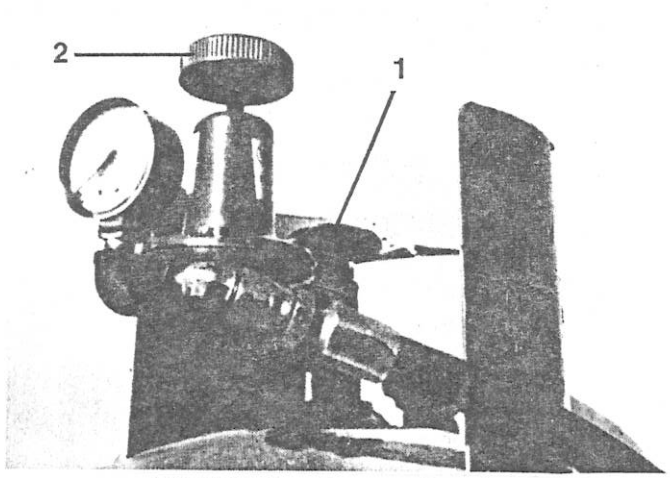


FIGURE 6 — Pressure Regulators

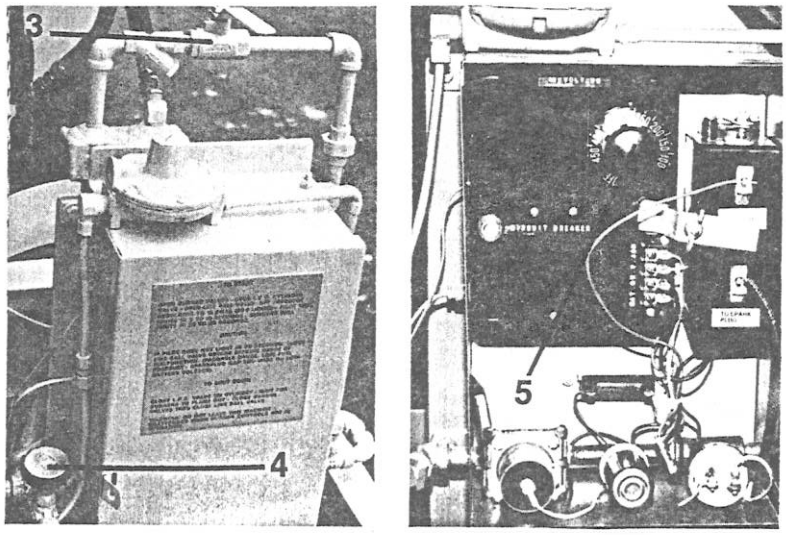


FIGURE 7 — Automatic Burner Control

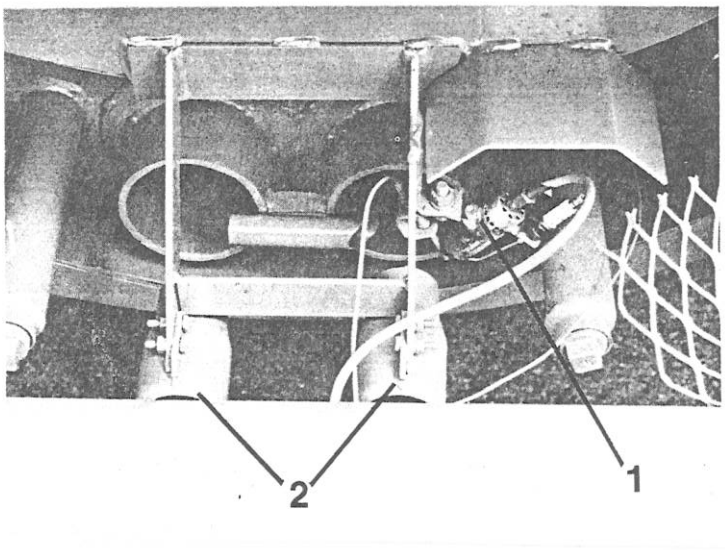


FIGURE 8

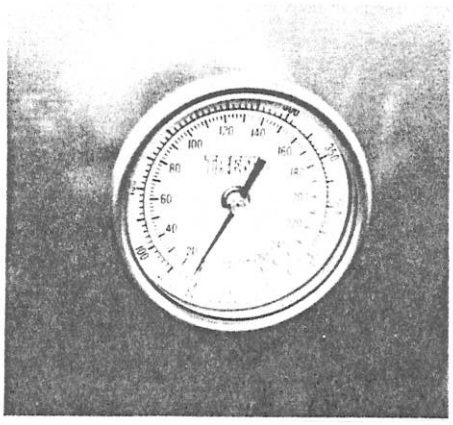


FIGURE 9 — Heat Transfer Oil Temperature Gauge

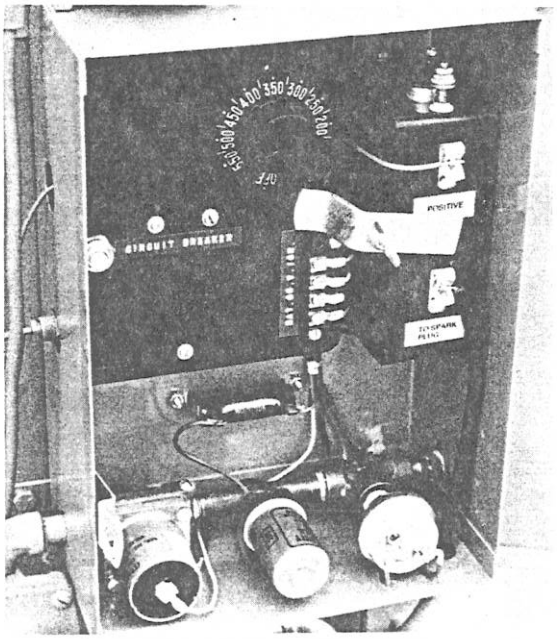


FIGURE 10 — Calibration of Temperature Control

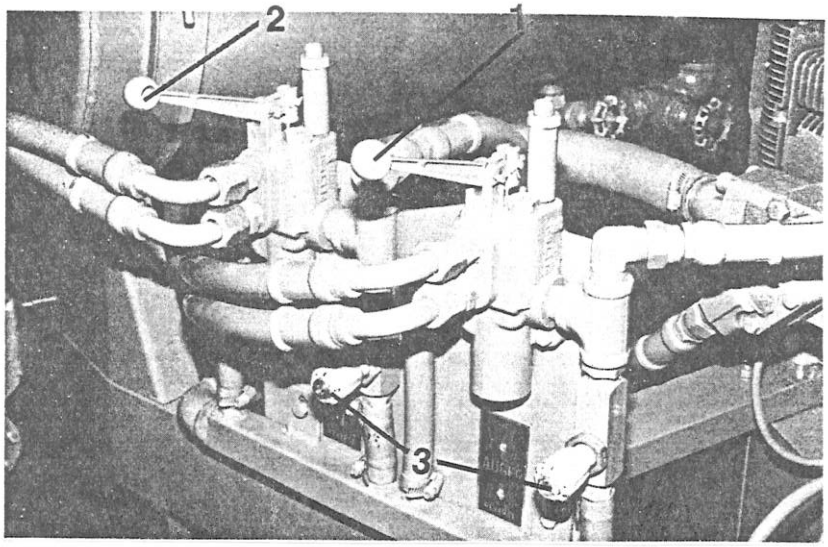


FIGURE 11

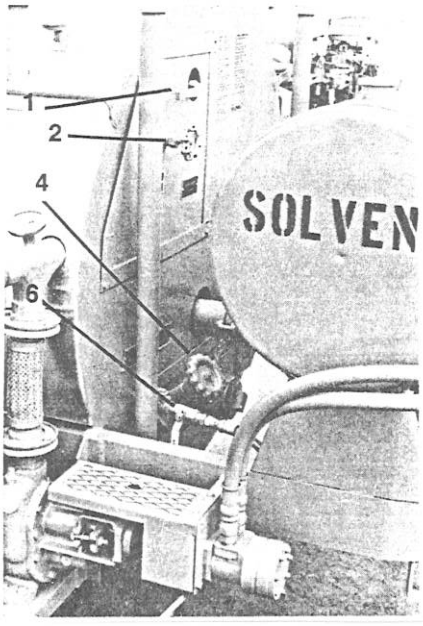


FIGURE 12

CHECKING TEMPERATURE CONTROL CALIBRATION

The temperature control system is calibrated at the factory during testing; however, it is good practice to check the calibration when the machine is first put into operation. And also checked again periodically. (Each 50 hours of operation is recommended). The gauge on the curbside to the rear of the fender registers the actual temperature of the heat transfer oil and it should coincide with the temperature control hand knob setting.

To check the calibration, the following procedure must be followed - check heat transfer oil level, it must be high enough to submerge the temperature gauge probe. Start up the burners. Set temperature control hand knob at about 250° F. Leave burners on until *200° F. registers on the temperature gauge*. Slowly turn the temperature control hand knob down until a click is heard and/or the burners shut off. If the temperature control hand knob, at this point, reads differently than the temperature gauge, recalibration is required.

RECALIBRATING THE TEMPERATURE CONTROLS

RECALIBRATION WHEN GAUGE READS LOWER THAN THE CONTROL

To recalibrate the temperature control, set the temperature control knob to 200° F. When the burners shut off, carefully pull the hand knob off the spindle. Be careful not to move the spindle during this operation. With a jeweler's screwdriver (or the flattened end of a paper clip) turn the adjusting screw inside the spindle *counterclockwise* no more than 1/8 turn to start the burners, to increase the temperature (1/8 turn will raise the temperature 15° F. to 20° F.), continue turning the screw each time the burners cut out until the gauge reads 200° F. Carefully replace hand knob. Both the hand knob and the temperature gauge should now read approximately 200° F.

RECALIBRATION WHEN GAUGE READS HIGHER THAN THE CONTROL

Turn the temperature control knob to 200° F. Carefully remove hand knob without moving spindle, turn adjusting screw *clockwise* each time burners start so as to stop them. Continue until oil temperature on gauge has dropped to 200° F. Turn adjusting screw *counterclockwise* slowly until burners start, then turn *clockwise* 1/8 turn and carefully replace control knob.

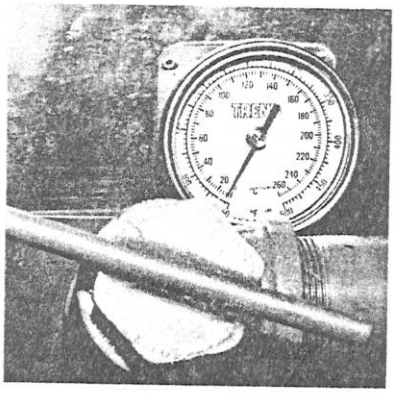


FIGURE 13

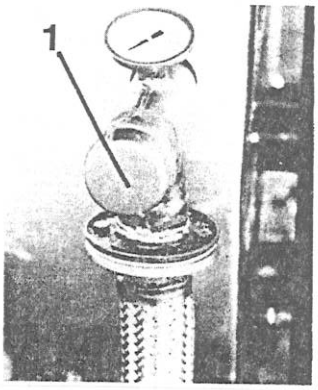


FIGURE 13A

TO START ENGINE

Gasoline or LPG Engines:

NOTE: It is recommended that you read the Engine Manual before you start the above type engines.

1. Return hydraulic controls to "off" position. See Figure 11.
2. Turn gasoline or propane valve on (if so equipped).
3. Move ignition switch to "on" position. Engage starter and choke as required.

Diesel Engine:

NOTE: It is recommended that you read the Engine Handbook before you start the above type engine.

1. Return hydraulic controls to "off" position. See Figure 11.
2. Turn fuel valve on if so equipped.
3. Turn starter key or switch to start engine.

New diesel engines are sometimes very difficult to start initially; this is because they have become air-bound. If the engine does not start after two or three cranking revolutions, suspect that air is in the fuel lines and it must be purged out. Begin by lightly loosening the fuel line connection at the delivery side of the fuel pump, crank the engine until foamless fuel is descharged, then retighten the connection. Repeat this procedure at each connection along the fuel line until the engine starts and runs indicating all of the air has been purged from the fuel lines.

AGITATION AND PUMPING

1. With engine running, start agitation by moving the auger hydraulic control (1) for clockwise rotation (Figure 11). If auger jams, control may be moved for counterclockwise rotation.
2. When sealant becomes liquid throughout, pumping action may begin.
   a. Move the pump hydraulic control (2) for pumping rotation. (Figure 11).
   b. Open recirculation valve (1) to allow sealant to recirculate.
   c. Open tank valve (4) to allow sealant to enter pump. Refer to Figure 12.
   d. Hydraulic flow control valves (3) have been added to increase the flexibility of the BC220 and BC220-4. See Figure 11. Counterclockwise rotation of the valves decreases hydraulic pressure. Consequently, the speeds of the material pump and auger may be varied. For best results keep both flow control valves turned in clockwise, unless it is necessary to independently slow pump or auger speed. To slow both pump and auger speed, reduce the speed of the engine.
   e. When sealant reaches application temperature (refer to sealant manufacturer's recommendation) pumping through applicator nozzle may begin. Thermometer located on top of material tank indicates material temperature. See Figure 13. Thermometer located in 2" line also indicates material temperature but only when material is flowing through lines. Figure 13A. Remove hose (2) from heating chamber and place hand applicator in tank rear opening with hand applicator valve (1) in "on" position. See Figure 14.
   f. Open applicator valve (1) to allow sealant to flow through hand applicator, see Figure 14.
   g. Adjust recirculation valve (1) to allow desired flow through applicator wand. Figure 12.
   h. Sealant may now be applied as desired. Turn hand applicator valve off before removing hand applicator from tank.

IMPORTANT:

When hand applicator is not in use, place it into tank rear opening. Open hand applicator valve to keep hose warm and unobstructed.

CAUTION:

Extreme care must be used when operating this equipment. Safety is the result of being careful and paying attention to details. Remember the propane flame is about 2200° F. Certain exposed parts of this machine, when operating, reach 500° F.; the sealant as high as 350° F. and the hydraulic oil may reach 200° F. Always wear protective clothing and eye protection. Be sure that all joints and fittings are tight and leakproof. Immediately replace any hose (sealant, propane or hydraulic) which show any signs of wear, fraying or splitting. Never has it been more true - "An ounce of prevention is worth a pound of cure."

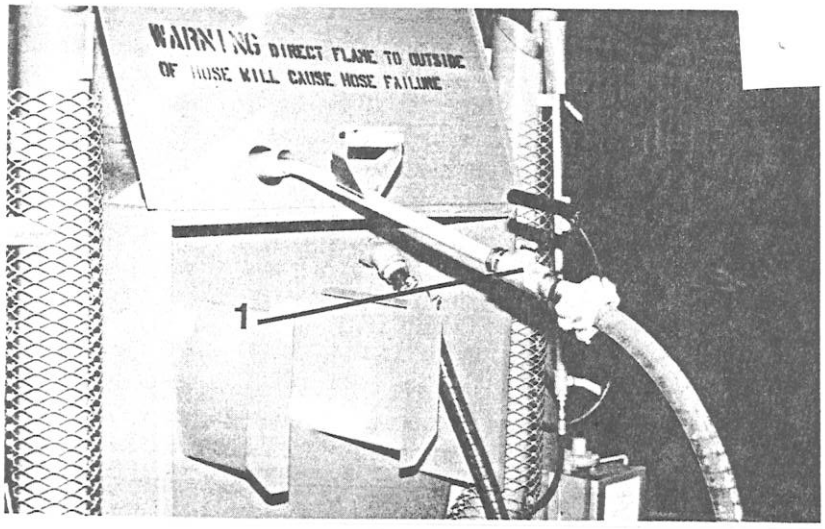


FIGURE 14

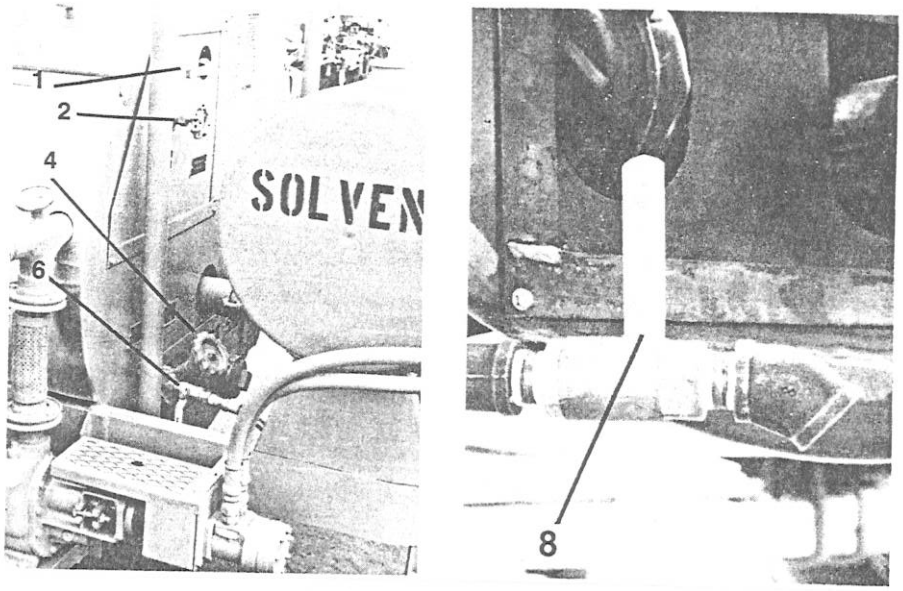


FIGURE 15 — Valves

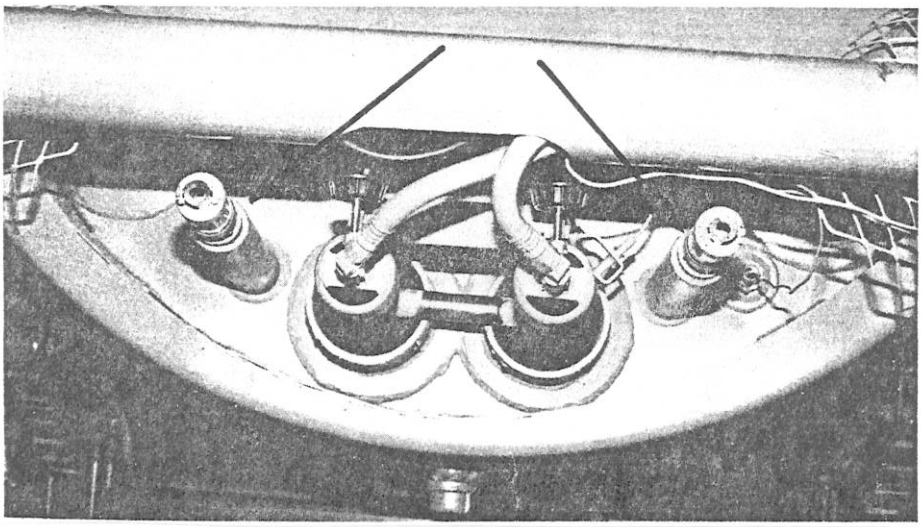


FIGURE 16 — Heating Elements

LOADING MACHINE

Loading the machine can be accomplished in two different ways:

1. Loading machine with solid material, and
2. Loading Machine with liquid single component material.

Solid Material Method:

When loading solid material into the sealant tank, the auger must be momentarily stopped, the lid lifted, the material lowered carefully into the tank and the lid closed again before the auger is restarted. Following this procedure exactly will prevent the hot (up to 350^{o} F.) material from splashing onto personnel and causing serious burns.

The solid materials must be added at intervals which will allow the auger to rotate without jamming. If blocks of material are fed in too quickly, jamming will result and slow down the melting process. Always try to maintain a melted material level at least a foot above the auger as a minimum.

Liquid Material Method:

1. Connect hose from the 2" line (1) to the sealant supply. All valves should be closed. Figure 13A.
2. Open tank valve (4) Figure 15.
3. Start engine (for instructions refer to page 13).
4. Actuate pump in reverse or suction direction. Figure 11.
5. When desired amount of material has been pumped into the tank, shut off the supply line valve at the supply source.
6. Remove hose from supply source and elevate hose above the level of the melting tank. Hold in this position until all material is displaced from hose.
7. Disengage pump, disconnect supply hose and close tank valve (4).

SHUTDOWN AND CLEANOUT PROCEDURE

1. Close valves on LPG cylinders. Wait for burners to flame out. Close burner valves then close line ball valve.
2. With hand applicator valve open, run material pump in the suction mode for approximately one minute.
3. Stop material pump. Close tank valve (4). Figure 15.
4. Remove hand applicator from tank, leaving hand applicator valve open.
5. Close recirculation valve (1) completely and open cleanout valve (6). Figure 15.
6. Engage pump in forward direction.
7. When solvent flows freely through hand applicator, close cleanout valve (6) and disengage pump.
8. Open drain valve (8) and reverse pump until all fluid is purged from lines.
9. Stop pump and close drain valve (8).
10. Shut down engine.
11. Coil hose in heating chamber for next use (Figure 5). Hang hand applicator on hooks. Cleanout of all lines and pump is complete.

Use of Heating Elements:

To keep material warm overnight simply plug heating elements into 110 volt supply line. Disconnect before using machine. See Figure 16.

NEVER RUN THE BURNERS UNATTENDED AS A MEANS OF MAINTAING AN ELEVATED TEMPERATURE OF THE MATERIAL.

STORING MACHINE

The BC220 and BC220-4 should be stored with the trailer tongue in an elevated position. This will allow the moisture condensation to setttle to the bottom rear of the heat transfer oil tank, above the drain plug. After extended periods of time, the water can be drained by removing the plug and replacing it when all water is desplaced. See Figure 17.

CAUTION: If there is any suspicion that moisture is still present after draining, warm heat transfer oil to 300^{o} F. for 2 to 3 hours to evaporate any moisture.

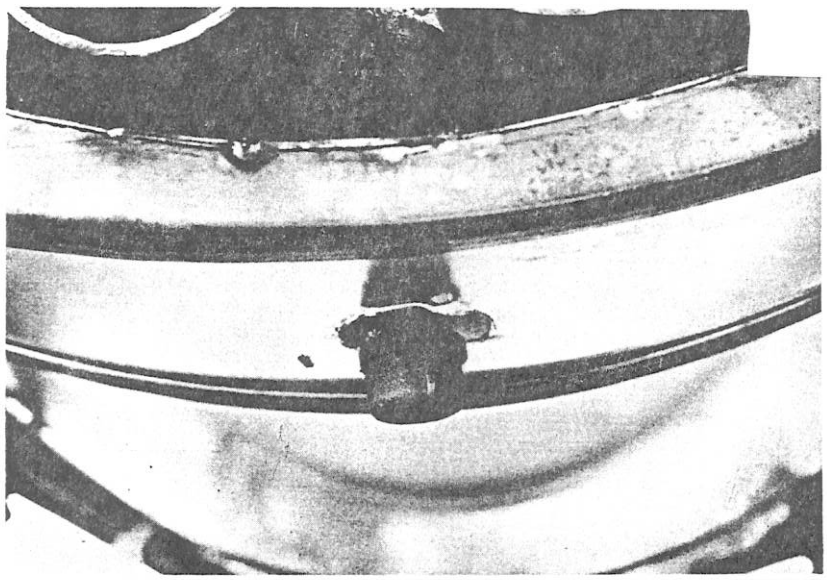


FIGURE 17 — Drain Plug

TROUBLE SHOOTING CHART

PROBLEM	CAUSE	REMEDY
Pilot will not light	Low fuel pressure.	Check pressure.
	Sparkplug gap too wide.	Close gap to .062.
	Low battery voltage.	Check battery.
	Orifice plugged.	Clean igniter orifice.
Burners will not light.	Low fuel pressure	Check Pressure
	Pilot not lit	See above.
	Thermocouple dislocated	Adjust so that 3/4" of tip is exposed to igniter flame.
	Thermocouple burned out	Replace thermocouple.
Burners will not shut off.	Foreign matter under gas solenoid valve seat	Remove top of valve and clean seat.
Auger will not rotate.	Sealant not to high enough temperature	Heat sealant to higher temperature before starting auger rotation.
	Too many blocks placed in machine at one time.	Continue heating and reverse auger direction.
	Inadequate hydraulic pressure.	Increase pressure by turning Hydraulic Flow Control Valve. See Fig. 11, Page 11.
Pump will not rotate.	Machine improperly cleaned, after previous use.	Heat inlet line to pump and other lines to liquify sealant.
	Material in Tank NOT to operating temperature.	Continue heating with auger in rotation.
	Inadequate hydraulic pressure.	Increase pressure by turning Hydraulic Flow Control Valve. See Fig. 11, Page 11.
	Pump damaged.	Refer to Roper Pump.
	Foreign object lodged in pump.	Remove foreign object.
Sealant material will not flow through recirculation valve with pump rotating in correct direction.	Sealant not to high enough temperature.	Heat sealant to operating temperature before pumping.
	Old material remains in lines.	Heat lines and recirculation valve to liquify old material.*
Sealant material flows through recirculation valve, but will not flow through hand applicator when recirculation valve is closed.	Applicator valve (1) in closed position. See Fig. 1	Open hand applicator valve.
	Machine improperly cleaned out in previous use.	Place hose in heating chamber to liquify old sealant and heat lines coming from pump with hand torch.
When applying sealant, it stops flowing from applicator tube.	Hand applicator valve (7) was left in off position too long. See Fig. 1.	Heat hose by placing in heating chamber to liquify sealant. Heat lines with hand torch.
	Too many blocks of material added to tank. Cold material entered pump and stopped flow.	Heat material hose by placing in heating chamber. Heat inlet line to pump and lines coming out of pump.
	Solid material entered supply line to pump.	Reverse pump rotation momentarily.

PROBLEM	CAUSE	REMEDY
Pump rotates but will not pump sealant material.	Pump worn or damaged.	Replace sealant pump.
	Pump rotating in wrong direction.	Move control lever for forward rotation.
	Foreign object lodged in inlet line to pump.	Dislodge foreign object from inlet line by reversing pump direction or disassembling inlet line.
	Machine improperly cleaned out.	Heat lines to liquify old sealant material.
Slow heat up of sealant.	Build up of coked or crystallized material on inside of material tank.	Allow machine to cool. Remove deposits and flush with solvent.

*NOTE: Remove Sealant Wand Assembly, re-hang Sealant Hose in Heating Chamber with open end hanging downward. Close door on Heating Chamber. Using Hand Torch, apply heat to lower part of Heating Chamber below hinged door. As old material liquifies, it will drip from Sealant Hose. DO NOT apply open flame directly to Sealant Hose.

SERVICE AND MAINTENANCE INSTRUCTIONS

PREVENTIVE MAINTENANCE INSTRUCTIONS

1. Conduct a general inspection of your machine at least once a week. Replace all worn or damaged parts, make any necessary adjustments and tighten all loose nuts or screws.
2. Keep regular replacement items in stock for emergency repairs, to avoid costly "down" time. Refer to general maintenance items, page 21.
3. Watch for leaks - tighten packing on pump and auger as necessary.
4. Clean machine externally periodically, using solvent compatible with sealant being used.
5. Follow recommended maintenance procedures on maintenance chart.

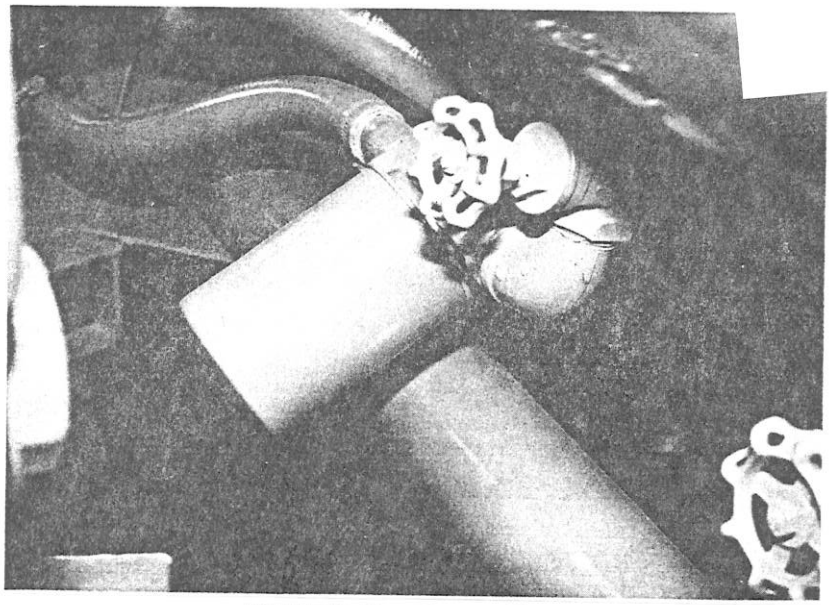


FIGURE 17 — Return Filter

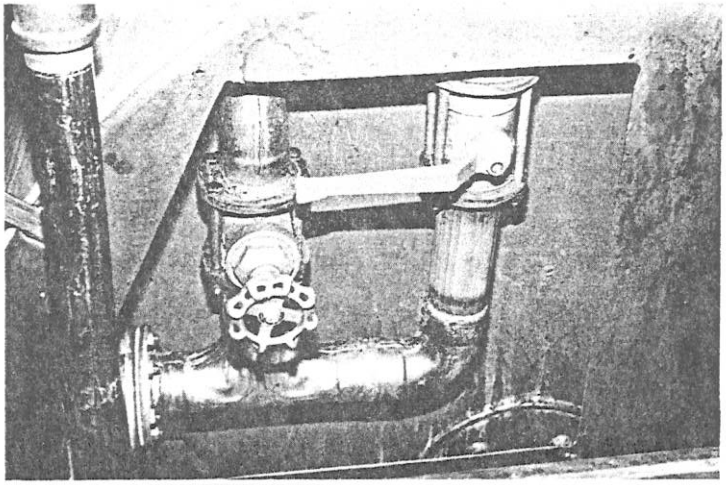


FIGURE 18 — Checking Valve Bolts

MAINTENANCE INSTRUCTIONS

ENGINE:

Check oil every 8 hours of operation. Change after the first 25 hours of operation and change every 100 hours thereafter.

Change oil filter after every 100 hours. See engine maintenance manual for other maintenance.

HYDRAULIC SYSTEM:

Change oil after every 500 hours of operation. Change return filter after every 500 hours. See Figure 17. Check oil level weekly. Oil level should be kept 3-5 inches from top of tank.

WHEEL BEARINGS:

Repack wheel bearings every 24,000 miles or every two years, using a good grade of bearing grease.

TONGUE JACK:

Lubricate tongue jack, using a good grade of bearing grease.

SEALANT PUMP:

Lubricate outboard bearings using a good grade of bearing grease. Adjust pump packing periodically. A slight drippage (several drops per minute) should be allowed. Refer to Pump Section for details. See page 40.

INTERNAL VALVES:

Check bolts which clamp recirculation valve and sealant valves in place. Proper torque is 20-25 ft.-lbs. Check after the first 8 hours of operation and again after every 500 hours of use. Watch for leaks. Replace gaskets if tightening does not stop leaks. See Figure 18.

AUGER:

Adjust auger packing periodically. Make sure gland is pulled up evenly. If pulled too tight, packing will overheat and score shaft. If too loose, packing will leak excessively. Adjust packing when auger is at operating temperature and wait 15 minutes between adjustments. A slight drippage (several drops per minute) should be allowed. See Figure 19. To replace packing, refer to Pump Section, page 40. Procedure for repacking auger is similar to procedure for repacking sealant pump.

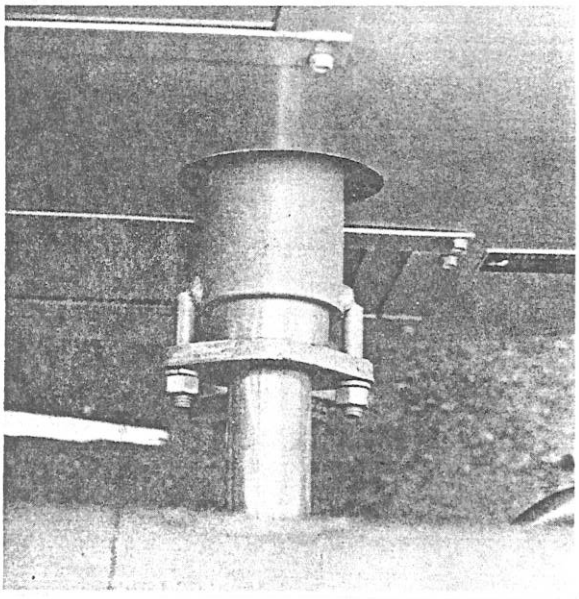


FIGURE 19 — Auger Packing

MAINTENANCE CHART

LOCATION	PROCEDURE	HOURS			
		8	50	100	500
Engine Check Oil Level	See Onan Engine Instruction Manual.	*			
Change Oil				*	
Battery	Maintenance Free				
Roper Pump Packing	Tighten as required, Seepage should be several drops/per minute.		*		
Heat Transfer Oil	Check		*		
	Change				*
Roper Pump Outboard Bearing	Lubricate using a good grade of bearing grease.		*		
Other Engine Maintenance	See Onan Operating and Maintenance Instructions.			*	
Engine Oil Filter	See Onan Operating and Maintenance Instructions.			*	
Hydraulic Oil	Check Oil	*			
	Change Oil				*
	For proper oil, see recommended fluids and lubricants, page 21.				
Wheel Bearings	Clean and repack--using good grade of bearing grease.	Every 24,000 miles or every two years			
Tongue Jack	Grease, using good grade of bearing grease.	Once a Year			
Auger	Adjust packing periodically to allow slight drippage, several drops per minute.		*		

RECOMMENDED FLUIDS & LUBRICANTS

APPLICATION	RECOMMENDED	FULL POINT
Engine Oil	Refer to Onan Engine Operating Manual.	
Heat Transfer Oil	Use heat transfer oil with these minimum specifications: Flash Point 575° Fire Point 600	65 Gal. (BC220) 130 Gal. (BC220-4)
LPG	Propane	200 Lbs.
Hydraulic Oil	RONDO OIL-HD-68	30 Gal.
Machine Cleanout (Solvent)	Use kerosene, diesel or recommended solvent for sealant material being used.	30 Gal.

WARNING

The Heat Transfer Oil in this machine is a grade that has been tested and recommended by CRAFCO, Inc. The addition of any grade of oil not specifically recommended by CRAFCO, Inc. shall be cause for the voidance of all warranties.

All oils subjected to high temperatures deteriorate with time and lose many of their characteristics. Tests conducted by CRAFCO, Inc. have determined that for best results and safety, the Heat Transfer Oil in this machine must be drained and replaced with CRAFCO, Inc. recommended oil after seven hundred and fifty (750) hours of operation or one (1) year, whichever occurs first.

GENERAL MAINTENANCE ITEMS

RECOMMENDED QUANTITY	DESCRIPTION	PART NO.
1 Set	Packing, Sealant Pump	29990
1 Set	Packing, Auger	21009
1	Hand Gun Assembly (wand)	27015
1	Applicator Valve	29240
1	Sealant Hose Assembly	27009
1	Engine Oil Filter	32122
1	Thermocouple	25204
1	Hour Meter	24076
1	Igniter Sparkplug	25215
1	Engine Fuel Filter	22073
1	Hydraulic Filter	22071
1	Air Filter	32096
1	Engine Fuel Pump 6/1/84	26053
1	Bracket	26054

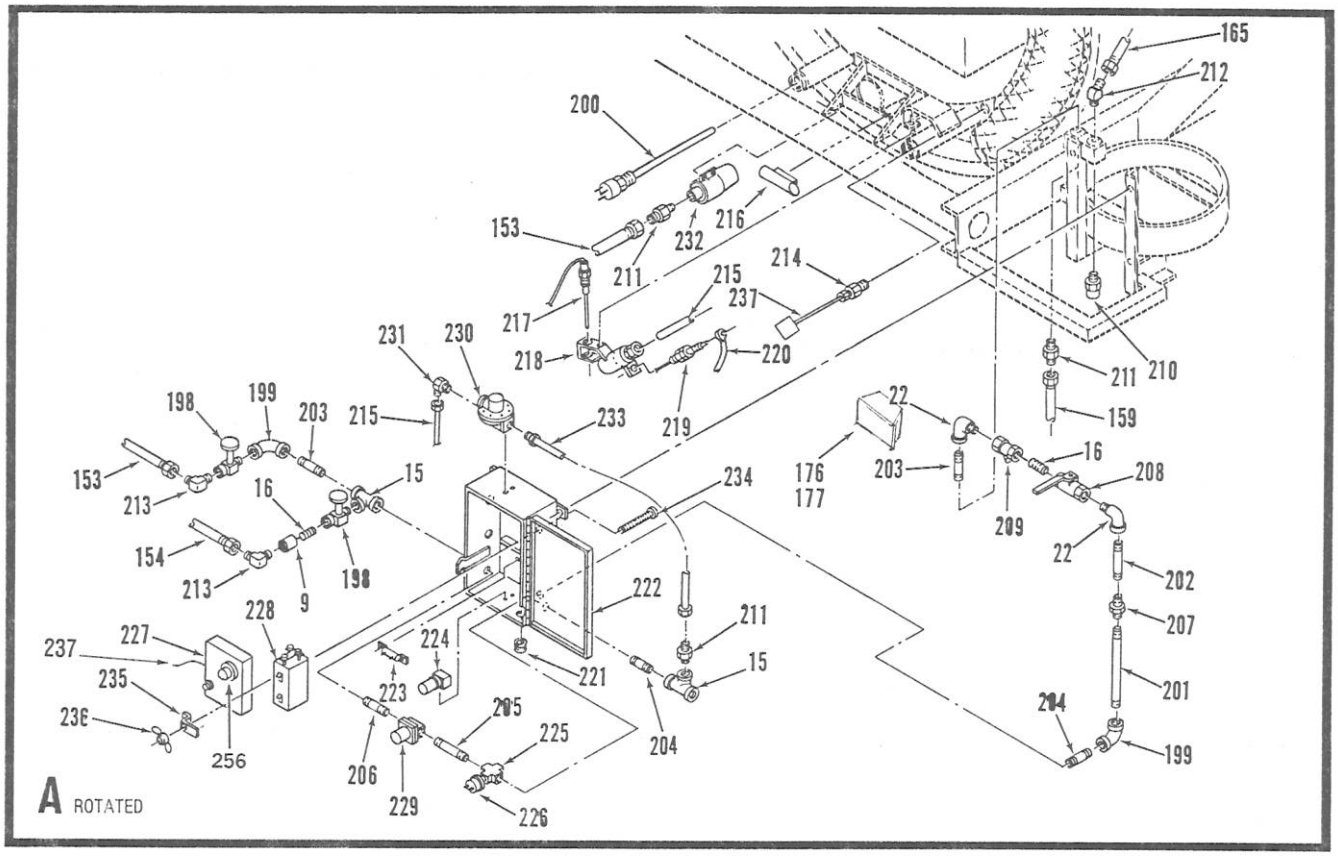
INSTRUCTIONS FOR ORDERING PARTS

Parts may be ordered directly from CRAFCO, Inc. or from your nearest CRAFCO Distributor. When ordering parts, give the following information:

1. Part Number
2. Machine Model, and
3. Serial Number from Name Plate

Write or telephone:

CRAFCO, Inc.
6975 West Crafco Way
Chandler, AZ 85226
Phone: (602)276-0406 Wats: 1-800-528-8242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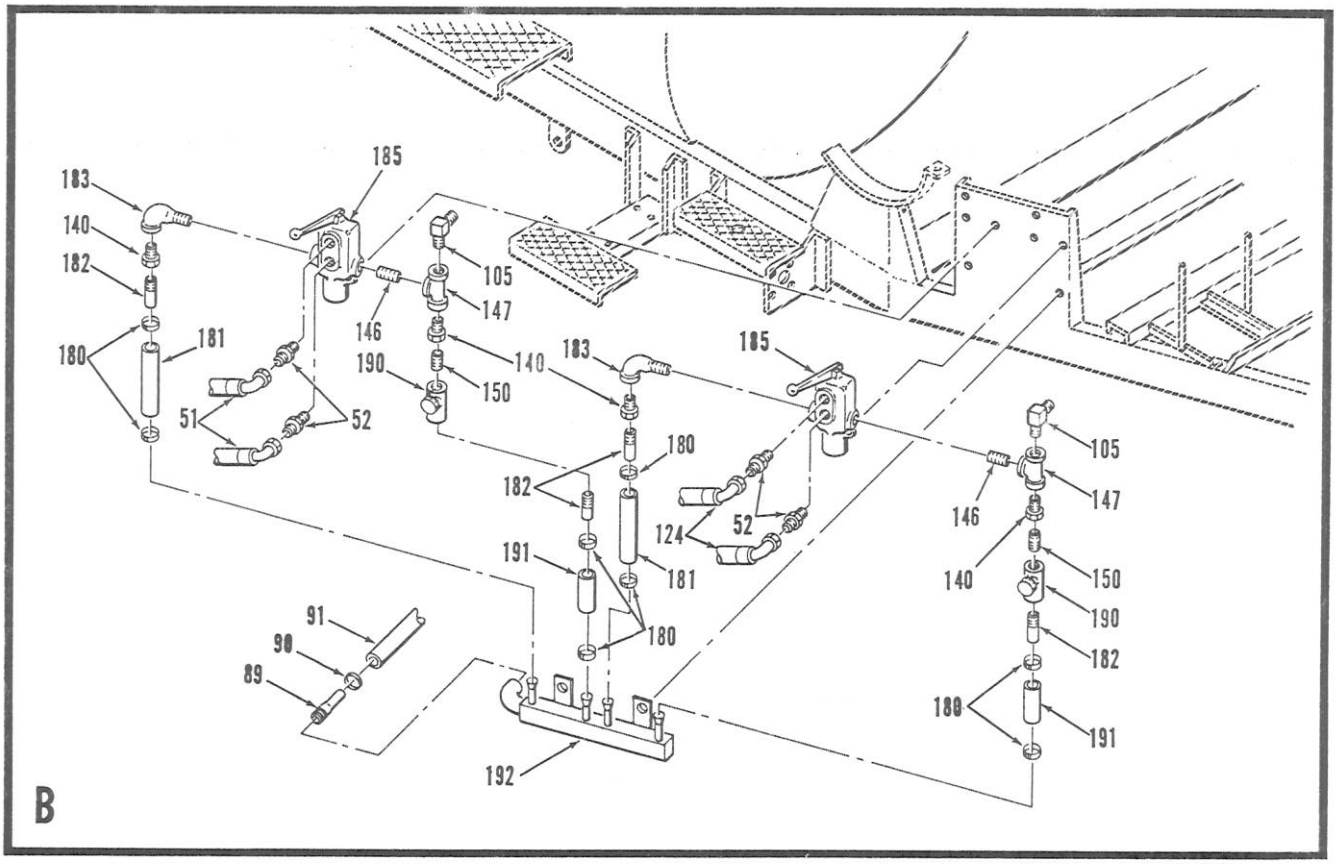
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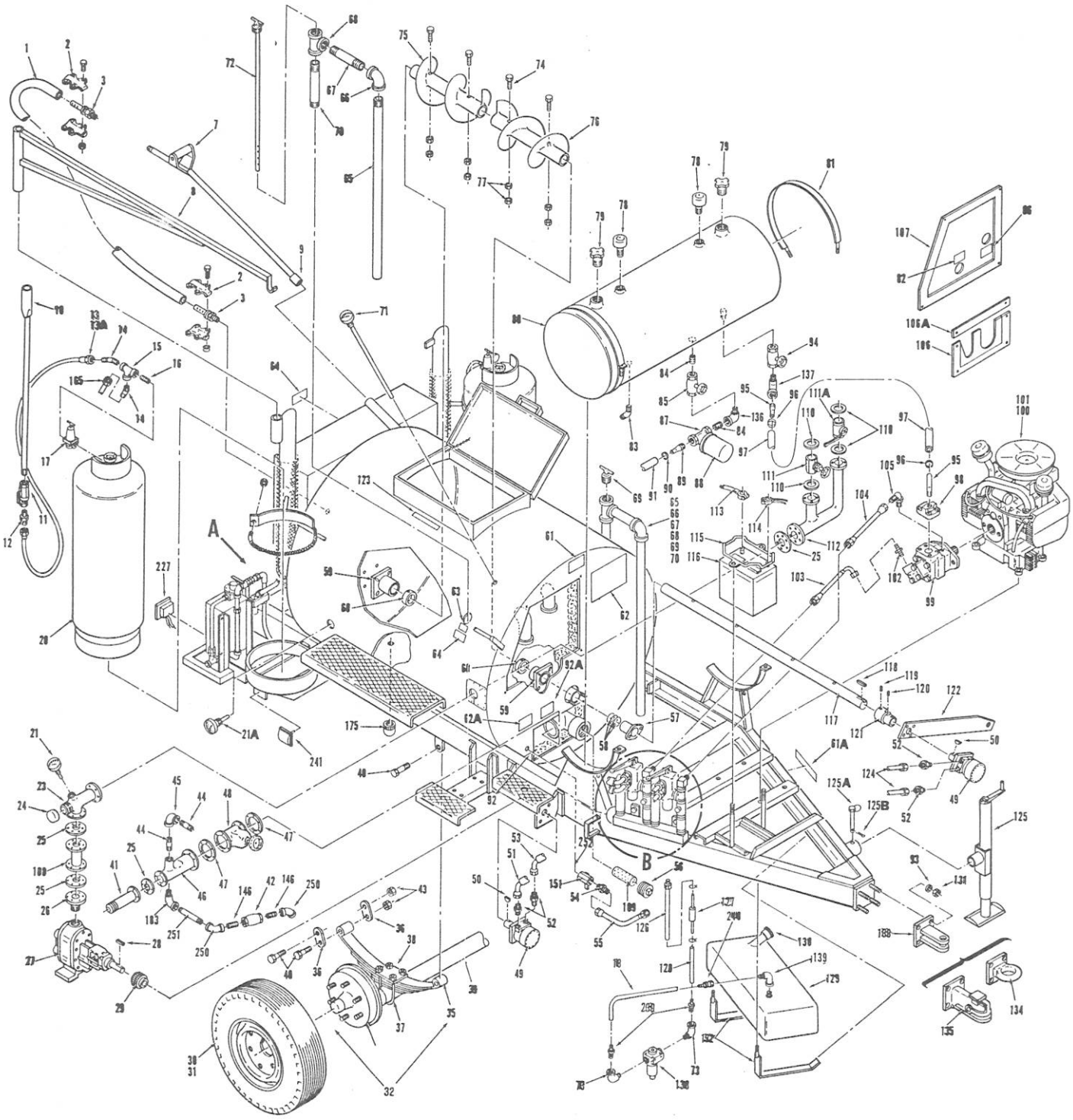


PARTS LIST

ITEM NO.	DESCRIPTION	QTY. PER UNIT	PART NO.
1.	Sealant Hose	1	27010
2.	Dixon "Boss" Hose Clamp (1")	2	27045
3.	Dixon Hose and Pipe Fitting	2	27040
4.	Hand Applicator Valve Handle	1	27080
5.	Modified 1" Bronze Ball Valve	1	29240
6.	1" x 3/4" Hex Pipe Bushing	1	28351
7.	Hand Applicator Asst.	1	27015
8.	Hose Support JIB	1	27020
9.	3/4" Pipe Coupler	2	28179
10.	Hand Torch	1	25015
11.	1/4" Globe Valve	1	29198
12.	Straight Male Adapter 4MJ-6MP	1	29837
13.	LPG Handtorch Hose — 200 Gallon	1	25135
13A.	LPG Handtorch Hose — 400 Gallon	1	25134
14.	4MJ — 4MP	2	29836
15.	1/4" Pipe Tee	3	28251
16.	1/4" Close Nipple	1	28001
17.	LPG Pressure Gauge	2	25060
18.	Hose, Gas Tank to Fuel Pump	1	22113
19.	LPG Pressure Regulator	2	25066
20.	LPG Storage Tank	2	25118
21.	Temperature Gauge — 3" Probe	1	25050
21A.	Temperature Gauge — 5" Probe	1	25051
22.	1/4" Street Elbow	4	28236
23.	Intermediate Piping Assembly	1	27003
24.	2" Pipe Cap	1	28273
25.	2" x 6 Hole Gasket	4	29050
26.	Pump Outlet Nipple Assembly	1	27051
27.	Sealant Pump	1	27029
28.	Sealant Pump Shaft Key	1	27017
29.	Sealant Pump Chain Coupling	1	22050
30.	Tire 9.50 x 16.5 6 Ply	2	23055
31.	Wheel and Rim 9.,50 x 16.5 8 Hole Chevy	2	23040
32.	Axle Assembly (Items 33-40)	1	23005
35.	Leaf Spring	2	23060
36.	Shackle Link	4	23075
37.	U-Bolt, Washers and Nuts	4 sets	23110
38.	Spring Tie-Down Plate	2	23070
39.	Axle and Brake Flange Assembly	1	23015
40.	Shackle Bolt	6	23100
41.	Pump Intake Nipple	1	27050
42.	3/4" Bronze Ball Valve	1	29227
43.	Shackle Nut	6	23105
44.	1/2" Pipe Nipple — 4" Long	2	28037
45.	1/2" Pipe Elbow	1	28208
46.	Lower Piping Assembly	1	27002
47.	3" x 8 Hole Gasket	2	29060
48.	3" Alleghany Gate Valve	1	29292
49.	Hydraulic Motor	2	22020
50.	Hydraulic Motor Shaft Key (1/4" x 1")	2	22021

ITEM NO.	DESCRIPTION	QTY. PER UNIT	PART NO.
51.	Hydraulic Hose Cont. Valve to Pump Motor	1	22103
52.	Jic Adaptor 12MJ-8MP	4	29846
53.	Hydraulic Hose Pump Motor to Control Valve	1	22109
54.	Jic Adaptor 8MJ-8MP	1	29844
55.	Solvent Hose, Tank to Valve	1	22108
56.	3-1/2" Pipe Plug	1	28291
57.	Packing Gland	1	21008
58.	Packing	1	21009
59.	Auger Shaft Bushing	2	21004
60.	2" Auger Shaft Collar	2	21011
61.	CRAFCO Nameplate	1	26179
61A.	Read Instruction Manual Plate	1	26176
62.	Instruction Plate	1	26185
62A.	Cleanout Valve Plate	1	26182
63.	Heat Transfer Oil Plate	2	26178
64.	Warning — Hot Plate	3	26175
65.	Breather Pipe (or vent)	2	21052
66.	1-1/2" Pipe Elbow	2	28212
67.	1-1/2" Nipple x 9" Long	2	28120
68.	1-1/2" Pipe Tee	2	28257
69.	Breather Pipe Cap	1	21018
70.	1-1/2" Pipe Nipple	2	28134
71.	Temperature Gauge — Long Stem	1	25053
72.	Dip Stick	1	21017
73.	1/8" Street Elbow	4	28235
73A.	Auger Assembly — 200 Gal.	1	21237
73B.	Auger Assembly — 400 Gal.	1	21238
74.	Auger Bolt 1/2" 13 x 3" Long	4	28766
75.	Right Spiral Auger	1	21006
76.	Left Spiral Auger	1	21007
77.	Auger Nuts	8	28504
78.	Tank Filter and Breather	2	26025
79.	Tank Filler Pipe Cap	2	26035
80.	Hydraulic Oil and Solvent Tank	1	22040
81.	Restraining Strap	2	22167
82.	Applicator Valve Plate	1	26183
83.	8MJ-8MP 45 Adapter	1	29861
84.	1" Close Nipple	2	28005
85.	1" Bronze Gate Valve	1	29242
86.	Recirculation Valve Plate	1	26180
87.	Oil Filter Body and Element (Hydraulic)	1	22070
88.	Oil Filter Element Only (Hydraulic	1	22071
89.	1" Combination Nipple	2	28662
90.	1" Hose Clamp Size 28 Gear Clamp	2	26084
91.	Manifold Hose	1	22106
92.	Drain Valve Plate	1	26184
92A.	Tank Valve Plate	1	26181
93.	5/8" Spring Washer	4	28650
94.	1-1/2" Gate Valve	1	29260
95.	1-1/2" Combination Nipple	2	28664
96.	1-1/2" Hose Clamp Size 20 Gear Clamp	2	26083
97.	1-1/2" Hose To Hydraulic Pump	1	22107
98.	Coupling Flange	1	22015

ITEM NO.	DESCRIPTION	QTY. PER UNIT	PART NO.
99.	Hydraulic Pump — Splined Shaft	1	22011
100.	2 Cylinder Gasoline Engine	1	22000
101.	2 Cylinder LPG Engine	1	22001
102.	Jic Adapter 12MJ-12MP	1	29847
103.	Hydraulic Hose — Pump to No. 2 Cont. Valve	1	22101
104.	Hydraulic Hose — Pump to No. 1 Cont. Valve	1	22100
105.	90 Jic Fitting 12MJ-12MP	3	29878
106.	Bottom Cover Plate	1	21225
106A.	Bottom Cover Top Strip	1	21229
107.	Top Cover Plate	1	21073
108.	Flex Hose Assembly	1	27095
109.	Outlet Strainer Assembly	1	21055
110.	2" Gaskets	4	29054
111.	2" Gate Valve	1	29270
111A.	2" Ball Valve	1	29271
112.	Upper Piping Assembly	1	27001
113.	Battery Cable — Hot	1	24015
114.	Battery Cable — Ground	1	24010
115.	Battery Hold-Down Frame	1	24005
116.	12V Battery	1	24000
117.	Auger Shaft — 200 Gal. Sealer	1	21233
117A.	Auger Shaft — 400 Gal. Sealer	1	21234
118.	Auger Shaft Key	1	21022
119.	Set Screw, 1/2" - 20 Auger Shaft Coupling	4	28977
120.	Set Screw, 3/8" - 24 Auger Shaft Coupling	4	28976
121.	Auger Shaft Coupling	1	26055
122.	Motor Bracket and Torque Arm	1	20084
123.	Do Not Open Plate	1	26177
124.	Hydraulic Hose — Auger Motor to Cont. Valve	2	22102
125.	Tongue Jack	1	230997
125A.	Tongue Jack Locator Pin	1	23093
125B.	Tongue Jack Captivating Clip	1	23094
126.	Upper Gasoline Hose	1	22111
127.	Gasoline Filter	1	22073
128.	Lower Gasoline Hose	1	22112
129.	Gasoline Tank	1	22153
130.	Gas Tank Filler Cap	1	26020
131.	5/7" 11 Hex Nut	4	28505
132.	Retaining Strap — Gas Tank	2	22166
133.	Pin Hitch	1	20015
134.	Pintel Hitch	1	20016
135.	Atwood 2" Ball Hitch	1	20017
136.	1" Street 90 Elbow	1	28240
137.	1-1/2" Street 90 Elbow	1	28242
138.	Fuel Pump	1	26053
138A.	Mounting Bracket	1	26054
139.	4MJ-4FP 90	1	29891
140.	Hex Pipe Brushing 3/4" to 1/2"	4	28348
146.	3/4" Close Nipple	5	28004
147.	3/4" Pipe Tee	2	28254
150.	1/2" Close Nipple	2	28003
151.	1/2" Ball Valve	1	29214
153.	LPG Hose to Driver Side Burner	1	25146

ITEM NO.	DESCRIPTION	QTY. PER UNIT	PART NO.
154.	LPG Hose to Curb Side Burner	1	25142
159.	LPG Hose Driveside LPG Tank to Control	1	25139
165.	LPG Hose to Curbside LPG Tank	1	25138
175.	1" Pipe Cap	1	28270
176.	Right Tail Light	1	24022
177.	Left Tail Light	1	24023
180.	Gear Hose Clamp	8	26082
181.	Manifold Hose (Long)	2	22105
182.	1/2" Hose Nipple	4	22062
183.	3/4" Street Elbow	2	28239
185.	Control Valve	2	22080
190.	Flow Control Valve	2	22081
191.	Manifold Hose (Short)	2	22104
192.	Manifold	1	22060
198.	1/4" Bronze Globe Valve	2	29197
199.	1/4" Pipe Elbow	2	28206
200.	29 3/8" Heating Element	2	24090
201.	1/4" Nipple 8" Long	1	28097
202.	1/4" Nipple 3-1/2" Long	1	28036
203.	1/4" Nipple 2-1/2" Long	2	28024
204.	1/4" Nipple 2" Long	1	28043
205.	1/4" Nipple 3" Long	1	28042
206.	1/4" Nipple 1-1/2" Long	1	28044
207.	1/4" Pipe Union	1	28326
208.	1/4" Bronze Ball Valve	1	29195
209.	1/4" Line Strainer	1	25208
210.	Safety Valve	1	25207
211.	6MS-4MP Straight Adapter	3	29839
212.	6MJ-4MP 45 Adapter	1	29857
213.	6MP-4MP 90 Adapter	2	29871
214.	Stuffing Box	1	25203
215.	Pilot Light Tube	1	25174
216.	Shunt Assembly	1	25197
217.	Thermocouple	1	25204
218.	Igniter Body	1	25214
219.	Spark Plug	1	25215
220.	Spark Plug Wire	1	25216
221.	Spark Plug Wire Grommet	1	25217
222.	Burner Control Cabinet	1	25201
223.	Resister Coil	1	25227
224.	Flasher Unit	1	25230
225.	1/4" Pipe Cross	1	28262
226.	1/4" Pressure Switch	1	25229
227.	500° F. Temperature Reg. Housing Assembly	1	25210
228.	Spark Control Unit	1	25225
229.	Burner Servo Control Valve	1	25235
230.	Pilot Pressure Regulator	1	25218
231.	90 1/8" Pipe by 1/4" Compressor	1	29772
232.	Burner Assembly	2	25172
233.	Feed Tube to Pilot Regulator	1	25219
234.	Captivating Screw	1	28712
235.	Captivating Clamp	1	26117
236.	1/4" 20 Wing Nut	1	28618

ITEM NO.	DESCRIPTION	QTY. PER UNIT	PART NO.
237.	500° F. Temp. Reg. and Sensing Tube Assembly*	1	25211
239.	No. 4 Straight Push-on Fitting	2	26750
240.	No. 4 Straight Swivel Push-on Fitting	1	26750
241.	Clearance Lamp (Red)	2	24092
250.	3/4" x 45 Pipe Elbow	2	28224
251.	3/4" Nipple 6" Long	1	28071
252.	1/2" Bronze Check Valve	1	29215
253.	DC-1645 Temperature Cont. Assembly	1	25175
254.	Complete Hose Set — 200 Gal.	1	22120
255.	Complete Hose Set — 400 Gal.	1	22121
256.	Temperature Indicator Dial	1	25220
B.	Hydraulic Control Panel (Detro Valves)	1	22141
B.	Hydraulic Control Panel (Energy Valves)	1	22142

* Located behind Temperature Indicator Dial

ENGINE SECTION

OPERATING AND MAINTENANCE INSTRUCTIONS
ENGINE SAFETY PRECAUTIONS

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

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

CAUTION:
This symbol refers to possible equipment damage.

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

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

General
Provide appropriate fire extinguishers and install them in convenient locations. Use an extinguisher rated ABC by NFPA.

Make sure that all fasteners on the engine are secure. Tighten supports and clamps, keep guards in position over fans, driving belts, etc.

If it is necessary to make adjustments while the engine is running, use extreme caution when close to hot exhausts, moving parts, etc.

Protect Against Moving Parts
DO NOT wear loose clothing in the vicinity of moving parts, such as PTO shafts, flywheels, blowers, couplings, fans, belts, etc.

Keep your hands away from moving parts.

Batteries
Before starting work on the engine, disconnect batteries to prevent inadvertent starting of the engine.

DO NOT smoke while servicing batteries. Lead acid batteries give off a highly explosive hydrogen gas which can be ignited by flame, electrical arcing or by smoking.

Verify battery polarity before connecting battery cables. Connect negative cable last.

Fuel System
DO NOT fill fuel tanks while engine is running, unless tanks are outside engine compartment.

DO NOT smoke or use an open flame in the vicinity of the engine or fuel tank. Internal combustion engine fuels are hightly flammable.

Fuel lines must be of steel piping, adequately secured, and free from leaks. Piping at the engine should be approved flexible line. DO NOT use copper piping on flexible lines as copper will harden and become brittle enough to break.

Be sure all fuel supplies have a positive shutoff valve.

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

DO NOT use exhaust gases to heat a compartment.

Make sure that your exhaust system is free of leaks. Ensure that exhaust manifolds are secure and are not warped by bolts unevenly torqued.

Engine Exhaust Gas (Carbon Monoxide) is Deadly!
Carbon monoxide is an ordorless, colorless gas formed by incomplete combustion of hydrocarbon fuels. Carbon monoxide is a dangerous gas that can cause unconsciousness and is potentially lethal. Some of the symptoms or signs of carbon monoxide inhalation are:

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

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

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

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

Keep the Unit and Surrounding Area Clean
Make sure that oily rags are not left on or near the engine.

Remove all oil deposits. Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and subsequent engine damage and may present a potential fire hazard.

PRE-START INSTRUCTIONS

BEFORE STARTING

Inspection: Inspect the engine visually before starting. Check for loose or missing parts or any damage occurring from shipment.

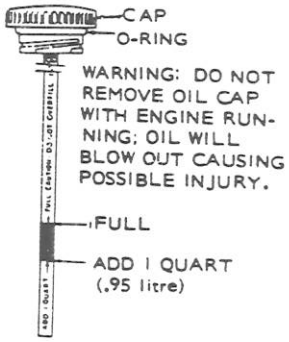
Crankcase Oil: Be sure to fill the crankcase with oil to the "FULL" mark on the oil level indicator. Use oil with the API (American Petroleum Institute) designation SE or SE/CC. Do not use an oil with the designation CD unless it also has designation SE and the oil manufacturer certifies it performs satisfactorily in gasoline engines.

Oil consumption may be higher with a multigrade oil than with a single grade oil if both oils have comparable viscosities at 210 F (99C). Therefore, single grade oils are generally more desirable, unless anticipating a wide range of temperatures. Use the proper grade oil for the expected conditions.

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

For new engines, nonleaded gasoline gives the most satisfactory results. For older engines that have previously used leaded gasoline, take off heads and remove all lead deposits from engine before switching to nonleaded gasoline.

OIL LEVEL INDICATOR



CAUTION: Failure to remove lead deposits from engine before switching from leaded to nonleaded gasoline could result in preignition causing severe damage to the engine.

WARNING: Never fill the tank when the engine is running. Gasoline fumes can ignite causing fire or explosion. Leave some space in the tank for fuel expansion.

STARTING

STARTING (Electric Start)

1. Move ignition switch to its "ON" position.
2. Push "START" button to crank engine.

If the engine does not start at first, inhibitor oil used at factory might have fouled the spark plugs. Remove the plugs, clean, dry thoroughly, and install. Inhibitor oil might cause heavy exhaust smoke when the engine is first started and is normal.

APPLYING LOAD

When applying the load to a new or reconditioned engine, do it gradually in about four steps, each not less than 30 minutes running time. Start with 1/4 load, then 1/2, 3/4, and full load.

STOPPING THE ENGINE

Disconnect all load before stopping the engine. Stop engines equipped with battery ignition by positioning the ignition switch to the "OFF" position.

HIGH ALTITUDE

For operation at altitudes of 2500 feet (760 m) or more, close the carburetor main jet adjustment slightly to maintain proper air-to-fuel ratio. Each 1000 feet (305 m) increase in altitude will reduce maximum power about four percent.

OPERATION

BREAK-IN PROCEDURE

Controlled break-in with proper oil and a conscientiously applied maintenance program will help assure satisfactory service for many hours from your Onan engine. Break-in or ideal fitting of all internal moving metal parts can best be achieved by maintaining proper cooling and correct lubrication during the running-in period. Using the wrong grade and weight of oil and high engine operating temperature conditions during break-in can result in engine damage. Run the engine at about half load for the first three hours with intermittent periods of full load to control engine break-in.

Check the oil level at least every five operating hours. Add oil to maintain proper level, but never overfill as oil will foam and enter the breather system.

HOT WEATHER OPERATION

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

1. Keep the engine cooling fins clean and free of obstruction to maintain maximum airflow to and from the engine.
2. Use the proper grade and weight of engine oil for the operating temperature conditions. Check the oil level each time you fill the fuel tank.
3. Check the battery water level more frequently than normal. High temperatures cause faster evaporation.

COLD WEATHER OPERATION

For operating temperatures below 32 F (0C), check the following items closely.

1. Use correct SAE oil for temperature conditions. Change oil only when engine is warm.
2. Use fresh fuel and protect against moisture condensation. Keep fuel system clean.
3. Keep batteries in a well-charged condition.
4. Partially restrict cool airflow to maintain proper engine temperature, but use care to avoid overheating.

DUST AND DIRT

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

MAINTENANCE

CRANKCASE OIL

The oil capacity is 3-1/2 U.S. quarts (3.3 litre) or 4 quarts (3.8 litre) with filter. Fill to the "FULL" mark on the oil level indicator. Use the following recommended oil number for expected ambient temperatures.

Above 40F (5C)	SAE30
10 to 40F (-12 to 5C)	SAE 10W-40
Below 10F (-12C)	SAE 5W-30

OIL LEVEL

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

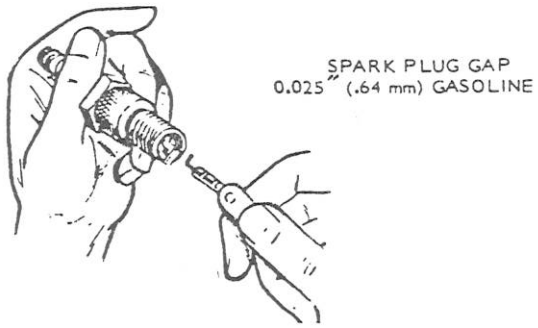
OIL CHANGE

Change crankcase oil after the first 25 hours of operation and after every 100 hours. If operating in extremely dusty conditions, change oil more frequently.

COOLING SYSTEM

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

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



CHECKING SPARK PLUG GAP

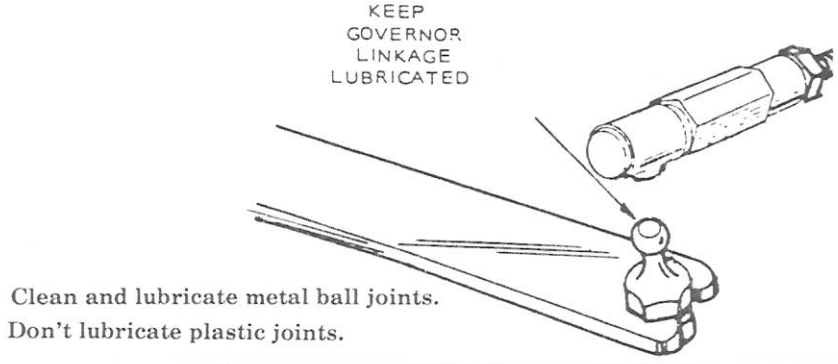
SPARK PLUGS

Check, clean and reset spark plugs every 100 operating hours. Replace spark plugs that show signs of fouling or electrode erosion. Replace with new spark plugs every 200 operating hours.

MAINTENANCE

GOVERNOR LINKAGE

The governor linkage must move freely through its entire travel. Every 50 hours of operation, clean the metal joints shown in Figure. Also inspect the linkage for binding, excessive slack and wear.

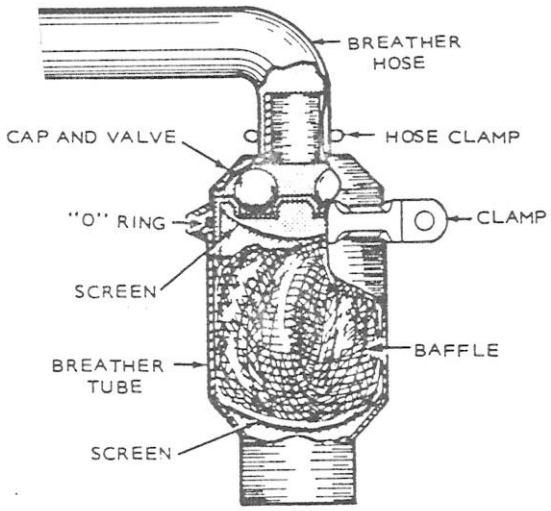


GOVERNOR LINKAGE BALL JOINT

CRANKCASE BREATHER

The crankcase breather maintains a partial vacuum in the crankcase during operation to control oil loss and ventilate the crankcase. To disassemble, remove the rubber cap from the crankcase tube and pry the valve out of the cap. Wash the valve in a petroleum-base solvent at regular intervals, and if defective, replace it. Also pull the baffle out of the breather tube and clean it. Install the valve with the perforated disk toward the engine.

WARNING: Use extreme care when cleaning with a petroleum-base cleaner due to fire hazard.



CRANKCASE BREATHER

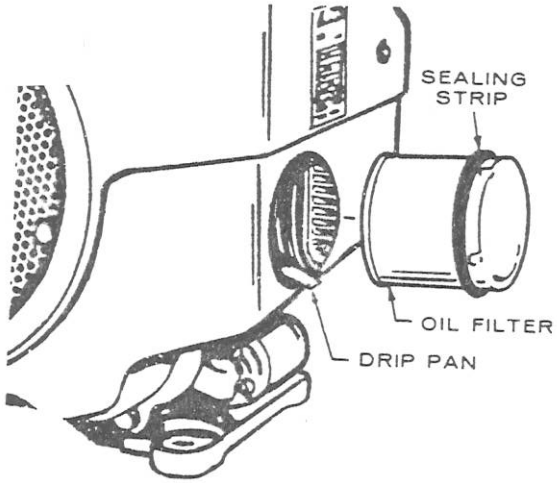
AIR CLEANER

Check air cleaner paper element every 50 hours. Clean element by tapping to shake off dirt. Depending on operating conditions for the engine, replace the paper element every 200 hours or whenever it becomes dirty.

CAUTION: Do not run engine with air cleaner removed. Intake of dirty air or solid materials could cause severe damage to engine parts.

OIL FILTER

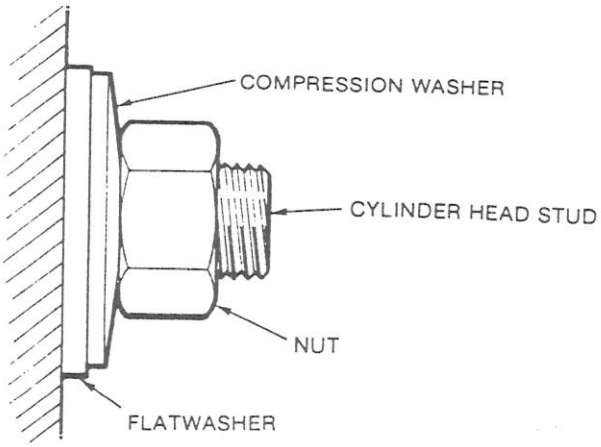
Change the crankcase oil filter every 200 hours. Remove the filter (see Figure) by turning counterclockwise, using a filter wrench. Add the strip provided with the filter to prevent air loss in the area indicated. It is advisable to wipe dry the drip pan located below the filter. Coat rubber gasket on filter with a film of oil before installing. Install the filter finger-tight plus 1/4 to 1/2 turn. Do not overtighten. If oil becomes so dirty that you cannot see the markings on the oil level indicator, change the filter and shorten the filter service period.



CRANKCASE OIL FILTER

CYLINDER HEAD TORQUE

Cylinder head nut compression washers are specified on some engine models only. When these washers are used, torque the head nuts in three 5 lb. ft. (7 N●m) steps to 14 to 16 lb. ft. (19 to 22 N●m).



CYLINDER HEAD COMPRESSION WASHER (NOT ON ALL MODELS)

CAUTION: Too much torque will flatten the compression washers and destroy their purpose. See Figure.

Head nuts which do not use the compression type washers should have a torque of 16 to 18 lb. ft (22 to 24 N●m).

EXHAUST SYSTEM

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

WARNING: Leaky exhaust systems emit noxious carbon monoxide fumes which are a potential safety hazard.

BATTERY

Check charge condition. Check electrolyte level. Add distilled water to keep electrolyte at its proper level. In freezing weather, run engine immediately after adding water. A specific gravity reading should be approximately 1.260 at 77F (25C). Keep battery connections tight and clean.

Onan recommends that qualified service personnel perform all major service. An engine service manual and complete parts catalog are available at additional cost. Contact your nearest authorized dealer or Onan parts and service center.

SERVICE THESE ITEMS	AFTER EACH CYCLE OF INDICATED HOURS					
	8	50	100	200	500	1000
Inspect Engine Generally *	x					
Check Fuel Supply	x					
Check Oil Level	x					
Clean Governor Linkage		x*				
Change Crankcase Oil			x*			
Check Breaker Points and Ignition Timing			x			
Check Spark Plugs			x			
Check Battery Electrolyte Level			x			
Clean Fuel Filter			x			
Adjust Valve Lash				x^1		
Replace Spark Plugs				x		
Replace Oil Filter				x*		
Replace Air Cleaner				x*		
Inspect Valves Grind if Necessary						x^1

* - Check for exhaust leaks, fuel leaks, proper mounting, etc.
x* - Perform more often under dusty or extreme cold weather conditions.
x^1 - For detailed maintenance - contact your Onan service center.

ADJUSTMENTS

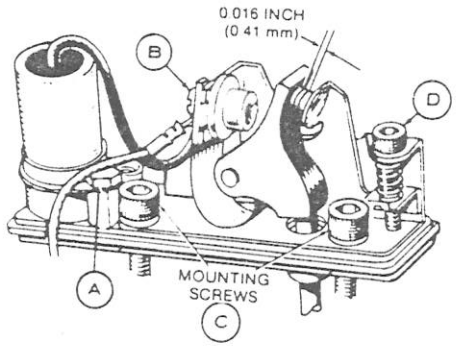
BREAKER POINTS - TIMING

To maintain maximum engine efficiency, change the breaker points every 200 hours of operation using the following procedure.

1. Remove spark plugs and rotate flywheel TC mark to 20 degrees BTC (points open); then rotate another 90 degrees clockwise to ensure points open fully.
2. Remove breaker box cover and unplug coil wire at coil (+) terminal.
3. Remove condenser (screw A) and detach condenser lead and coil lead (screw B).
4. Remove two Allen screws (C) and lift breaker assembly from engine.
5. Replace condenser and point assembly with new parts and reinstall using above procedure in reverse order of removal.
6. Using Allen wrench at screw (D), adjust point gap 0.016 inch (0.4mm) using a clean, flat thickness gauge.

Setting point gap accurately adjusts engine timing.

7. Replace breaker box cover and spark plugs.

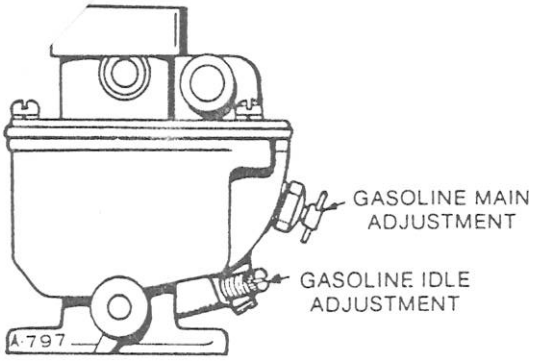


BREAKER POINT ADJUSTMENT

CARBURETOR ADJUSTMENT

1. Start engine and allow it to warm up.
2. Check to see that ignition and governor operation are normal.
3. With no load on engine, turn carburetor idle adjustment slowly in then out until best normal idle speed (2400 rpm) is achieved (1 to 1-1/2 turns open is normal).
4. Pull outward on governor linkage to slow engine to 800 to 900 rpm and set idle adjustment for smooth operation.
5. Release governor linkage to allow engine to accelerate. The main adjustment is correct if engine accelerates without a lag. If not, turn main adjustment out about 1/2 turn and repeat check until engine accelerates evenly without a lag.
6. Set throttle stop at desired speed.
7. With load applied, turn main adjustment slowly in then out until best normal speed is achieved.

CAUTION: Loosen packing nut before turning main fuel adjustment and tighten to a snug fit after adjustment has been made. Hold the adjustment while tightening packing nut.



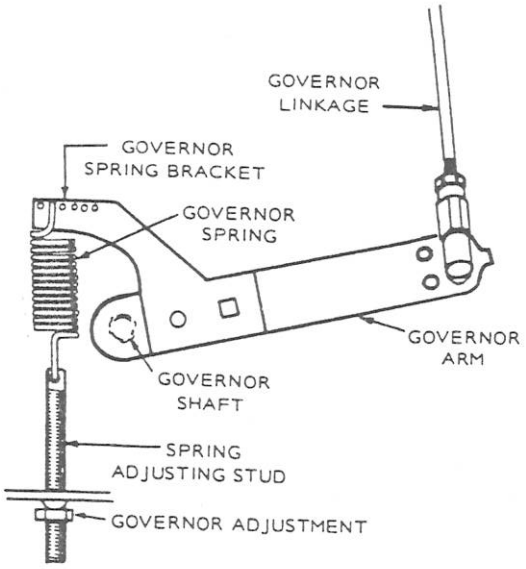
CARBURETOR ADJUSTMENTS

GOVERNOR ADJUSTMENT

The governor should allow a nominal engine speed of 2400 rpm at no load. The no load speed should be slightly higher (90 rpm) than the speed requirements of the connected load. Using a tachometer, check engine speed and adjust the governor as follows.

Speed: Turn speed adjusting nut in to increase speed or out to decrease speed, see Figure.

Sensitivity: Referring to Figure, move spring toward governor shaft to increase sensitivity and away from governor shaft to decrease sensitivity. The engine speed drop from no load to full load should not be less than 100 rpm.



GOVERNOR ADJUSTMENTS

GENERAL INFORMATION

ENGINE MODEL REFERENCE

Identify your model by referring to the MODEL and SPECIFICATION NUMBER as shown on the unit nameplate. Always use this number and the engine serial number when making reference to your engine.

How to interpret MODEL NUMBER.

NHA	-	MS	/	123	C
1		2		3	4

1. Factory code for general identification purposes.
2. Specific type: MS—electric starting.
3. Factory code for optional equipment supplied.
4. Specification (Spec Letter) or repair, contact an Onan service center. Trained mechanics will assure expert repair service on your Onan engine.

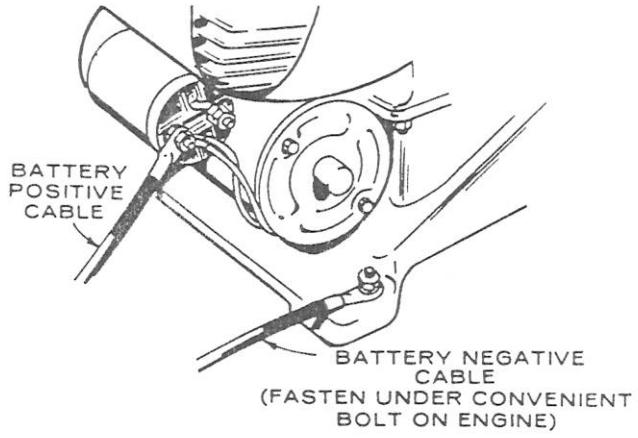
OUT-OF-SERVICE PROTECTION

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

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

BATTERY CONNECTIONS (Engines with Automotive Type Separate Starter)

Connect the 12-volt battery positive cable to the engine start switch terminal. Connect the battery negative cable to the ground point on the engine oil base (see Figure).



BATTERY CONNECTIONS

RUNNING REPLACEMENT PARTS

Oil Filter	122-0323
Oil Filter Air Seal	122-0347
Air Filter	140-1228
Breather Tube Baffle	123-0865
Spark Plugs	167-0240
Ignition Tune-Up Kit (points & condenser)	160-1161
Carburetor Repair Kit	141-0371
Fuel Pump Repair Kit	149-0526
Carbon Removal Gasket Kit	168-0121

A complete Onan parts catalog is available—contact your Onan parts and service center or authorized dealer.

SPECIFICATIONS

Displacement	.60 cu in. (983 cm^3)
Cylinder Bore	3,563 inch (90.5 mm)
Piston Stroke	3 inch (76 mm)
Horsepower	
NHA @ 3000 rpm	18 BHP (13.4 kW)
NHAV @ 3300 rpm	20 BHP (14.9 kW)
NHB @ 3000 rpm	17.5 BHP (13.1 kW)
NHBV @ 3200 rpm	19.5 BHP (14.5 kW)
Compression Ratio	
NHA, NHAV	6.5 to 1
NHB, NHBV	7.0 to 1
Ventilation Required @ 3600 rpm	
NHA, NHB	1100 cfm (31.14 m^3/min)
NHAV, NHBV	1200 cfm (33.97 m^3/min)
Oil Capacity	3.5 quart (3.3 litre)
Oil Capacity with Filter Change	4 quart (3.8 litre)
Combustion Air (3600 rpm)	80 cfm 2.3 m^3)
Fuel	Nonleaded or Regular Grade Gasoline
Battery	12 Volt

TUNE-UP SPECIFICATIONS

Cylinder Head Torque (Models with special compression washers)	15 lb. ft. (20.4 N•m)
Cylinder Head Torque (std)	18 lb. ft. (24 N•m)
Spark Plug Gap	0.025 inch (0.64 mm)
Breaker Point Gap	0016 inch (0.41 mm)
Ignition Timing (Fixed), Electric Start Units	20°BTC
Tappets (Cold) Intake	0.003 inch (0.08 mm)
Exhaust	0.012 inch (0.30 mm)

PUMP SECTION

ROPER PUMP INSTRUCTIONS

Operate the pump under normal conditions and, after a short run-in period, examine packing for leakage. If leakage is excessive tighten locknuts evenly until there is only slight leakage from the packing rings. This slight leakage is a necessary and normal condition for packing and allows for expansion and proper seating.

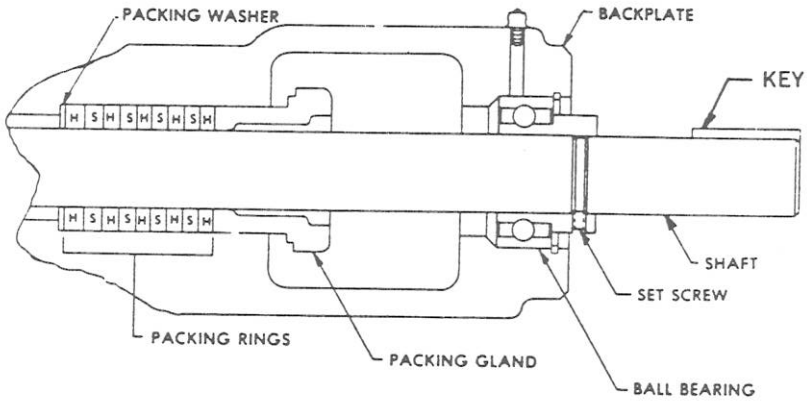
NOTE: WHERE LIQUID BEING HANDLED IS HAZARDOUS OR VOLATILE, FULL PRECAUTIONS SHOULD BE TAKEN DURING THE RUN-IN PERIOD.

To replace packing on "H" pump remove key, two nuts and clips, packing gland and packing rings. On "HB" and "GHB" pumps, remove two nuts, clips, spring clip, packing gland and packing rings. (Packing hooks are commercially available to assist in removing the packing rings). Clean the shaft and adjacent parts. Examine the shaft, if it is excessively worn or scored, replace the shaft.

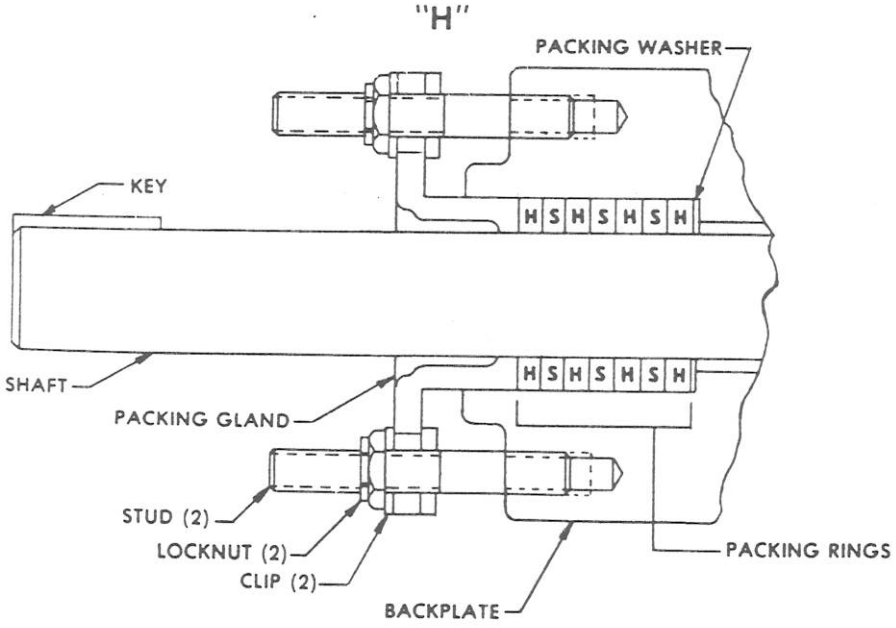
Insert packing rings alternating hard (H) and soft (S) rings as shown, making sure the joints are staggered 180 degrees. Use split ring bushings or a flexible packing tamper to seat each ring before adding the next ring. The rings must not be tamped or seated in place too tightly. Check shaft for free movement after each ring is installed. When the packing box is sufficiently full to allow entry of the packing gland (about ¼") reassemble the packing gland, clips and nuts. Draw up evenly on the packing gland to assure proper seating of the packing, and then loosen nuts about ½ turn. Do not cock the packing gland. (This could cause binding or heating of the shaft). Before operating the pumps see run-in instructions above.

3600, 4600 PACKED BOX

"HB"



"H"



PROPANE BURNER SYSTEM

IF THE SYSTEM FAILS TO IGNITE PROPERLY:

PROBABLE CAUSE	SOLUTION
1. Low gas pressure.	1. 20 psi minimum at tank, refill tank if needed.
2. Thermocouple at pilot not heating up.	1. Adjust thermocouple position.
	2. Replace thermocouple if faulty.
3. Thermocouple loose at connector to control box.	1. Tighten to ensure good connection.
4. No voltage at OP (servo) valve.	1. No. 1 - 3 above (Probable cause).
	2. Faulty "black" control box. Replace if necessary.
	3. Heating oil at specified temperature, same as temperature dial.
	4. Incorrect temperature calibration. Re-calibrate.
	5. Broken or faulty thermocouple in heating oil tank. Replace if necessary.
5. Voltage at servo (OP) but main burners will not ignite.	1. Dirt in servo; disassemble and clean.
	2. Clogged main gas screen. Remove and clean.
	3. Clogged orifice(s) at main burner. Remove and clean.
	4. Incorrrect or dirty fuel. (Vapor/liquid burner systems).
	5. Valves to burners closed.
6. Circuit breaker "blown".	1. Check and correct short(s).

IF BURNERS FAIL TO SHUT-OFF

PROBABLE CAUSE	SOLUTION
1. Dirt under seat of servo (OP) valve.	1. Disassemble servo (OP) and clean.
2. Faulty "black" box of thermocouple.	1. Replace.
3. Heating oil not at temperature set on control.	1. Turn control dial to off.
	2. Calibrate control, if necessary.

IF PILOT FAILS TO LITE

PROBABLE CAUSE	SOLUTION
1. Low battery voltage.	1. 12.0 Volts at battery/recharge. Replace if necessary.
2. No Voltage to right terminal of pressure switch.	1. See No. 1 above.
	2. Broken/loose wire from battery. Tighten/replace.
3. Low gas pressure. (no voltage at left hand terminal of pressure switch when gas valve opened.)	1. 20 psi pressure minimum. Refill if necessary.
	2. Faulty pressure switch.
4. No spark at ignitor.	1. Incorrect gap at ignitor plug.
	2. Faulty flasher unit.
	3. Faulty coil "box".
	4. Loose wire at ignitor plug or coil "box".
	5. See No. 1 - 3 above.
	6. Faulty ignitor plug.
5. Clogged line or orifice at pilot.	1. Inspect and clean/correct as necessary.
6. Loose connector in gas line.	1. Check for leaks; correct as necessary.
7. Circuit breaker "blown".	1. Find "short"; correct as necessary.

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