SB2170E00 Feb. 1999

SERVICE MANUAL CONTENTS

NOTICE

This form lists the contents of the complete Service Manual for this product. The items listed with form numbers are available and included in the manual. If form numbers listed with mark(*) are, they are not available for the initial release of the manual. When items are updated, or supplements added, they will be announced in preview and should be ordered as they become available.

TITLE	FORM NUMBER
Service Manual Contents Safety Torque Specifications	SB2170E00 SB2003E00 SB2004E00
ENGINE	
Hercules 2.7 Liter LPG Engine Hercules 2.7 Liter LPG Engine D & A Delco Remy CS-121 Series Alternator	SB2171E00 SB2172E00 SB2007E02
POWER TRAIN	
Power Train Power Train D & A	SB2174E00 SB2175E00
VEHICLE SYSTEMS	
Vehicle Systems Vehicle Systems D & A Mast Systems Hydraulic System Schematic Electric System Schematic	SB2176E00 SB2177E00 SB2143E03 SB2178E00 SB2179E00
OPERATION & MAINTENANCE	
Operation & Maintenance Manual	SB2155E01

WARNING

SAFETY

A WARNING

The proper and safe lubrication and maintenance for this machine, recommended by DOOSAN, are outlined in the OPERATION & MAINTENANCE GUIDE for this machine.

Improper performance of lubrication or maintenance procedures is dangerous and could result in injury or death. Read and understand the OPERATION & MAINTENANCE GUIDE before performing any lubrication or maintenance.

Theserviceman or mechanic maybe unfamiliar with many of the systems on this machine. This makes it important to use caution when performing service work. A knowledge of the system and/or components is important before the removal or disassembly of any component.

Because of the size of some of the machine components, the serviceman or mechanic should check the weights noted in this Manual, Use proper lifting procedures when removing any components.

Following is a list of basic precautions that should always be observed.

- 1. Readand understand all Warning plates and decals on the machine before operating, lubricating or repairing the product.
- 2. Always wear protective glasses and protective shoes when working around machines. In particular, wear protective glasses when pounding on any part of the machine or its attachments with a hammer or sledge. Use welders gloves, hood/goggles, apron and other protective clothing appropriate to the welding job being performed. Do not wear loose-fitting or torn clothing. Remove all rings from fingers when working on machinery.
- **3.** Do not work on any machine that is supported only by lift jacks or a hoist. Always use blocks or jack stands to support the machine before performing any disassembly.
- 4. Lower the forks or other implements to the ground before performing any work on the machine. If this cannot be done, make sure the forks or other implements are blocked correctly to prevent them from dropping unexpectedly.

A WARNING

Do not operate this machine unless you have read and understand the instructions in the OPERATOR'S GUIDE. Improper machine operation is dangerous and could result in injury or death.

- 5. Use steps and grab handles (if applicable) when mounting or dismounting a machine. Clean any mud or debris from steps, walkways or work platforms before using. Always face machine when using steps, ladders and walkways. When it is not possible to use the designed access system, provide ladders, scaffolds, or work platforms to perform safe repair operations.
- 6. To avoid back injury, use a hoist when lifting components which weigh 23 kg (50 lb.) or more. Make sure all chains, hooks, slings, etc., are in good condition and are of the correct capacity. Be sure hooks are positioned correctly. Lifting eyes are not to be side loaded during a lifting operation.
- 7. To avoid burns, be alert for hot parts on machines which have just been stopped and hot fluids in lines, tubes and compartments.
- 8. Be careful when removing cover plates. Gradually back off the last two bolts or nuts located at opposite ends of the cover or device and pry cover loose to relieve any spring or other pressure, before removing the last two bolts or nuts completely.
- **9.** Be careful when removing filler caps, breathers and plugs on the machine. Hold a rag over the cap or plug to prevent being sprayed or splashed by liquids under pressure. The danger is even greater if the machine has just been stopped because fluids can be hot.
- **10.** Always use tools that are in good condition and be sure you understand how to use them before performing any service work.
- Reinstall all fasteners with same part number. Do not use a lesser quality fastener if replacements are necessary. Do not mix metric fasteners with standard nuts and bolts.
- **12.** If possible, make all repairs with the machine parked on a level, hard surface. Block machine so it does not roll while working on or under machine.

\Lambda WARNING

- Disconnect battery and discharge any capacitors (electric trucks) before starting to work on machine. Hang "Do Not Operate" tag in the Operator's Compartment.
- 14. Repairs, which require welding, should be performed only with the benefit of the appropriate reference information and by personnel adequately trained and knowledgeable in welding procedures. Determine type of metal being welded and select correct welding procedure and electrodes, rods or wire to provide a weld metal strength equivalent at least to that of parent metal.
- **15.** Do not damage wiring during removal operations. Reinstall the wiring so it is not damaged nor will it be damaged in operation by contacting sharp corners, or by rubbing against some object or hot surface. Do not connect wiring to a line containing fluid.
- **16.** Be sure all protective devices including guards and shields are properly installed and functioning correctly before starting a repair. If a guard or shield must be removed to perform the repair work, use extra caution.
- **17.** Always support the mast and carriage to keep carriage or attachments raised when maintenance or repair work is performed, which requires the mast in the raised position.
- 18. Loose or damaged fuel, lubricant and hydraulic lines, tubes and hoses can cause fires. Do not bend or strike high pressure lines or install ones which have been bent or damaged. Inspect lines, tubes and hoses carefully. Do not check for leaks with your hands. Pin hole (very small) leaks can result in a high velocity oil stream that will be invisible close to the hose. This oil can penetrate the skin and cause personal injury. Use cardboard or paper to locate pin hole leaks.
- 19. Tighten connections to the correct torque. Make sure that all heat shields, clamps and guards are installed correctly to avoid excessive heat, vibration or rubbing against other parts during operation. Shields that protect against oil spray onto hot exhaust components in event of a line, tube or seal failure must be installed correctly.
- **20.** Relieve all pressure in air, oil or water systems before any lines, fittings or related items are disconnected or removed. Always make sure all raised components are blocked correctly and be alert for possible pressure when disconnecting any device from a system that utilizes pressure.

- **21.** Do not operate a machine if any rotating part is damaged or contacts any other part during operation. Any high speed rotating component that has been damaged or altered should be checked for balance before reusing.
- 22. On LP equipped lift trucks, be sure to close the valve on the LP tank before service work is performed. Always close the valve on the LP tank when the lift truck is being stored. Do not check for LP leaks with an open flame.
- 23. Caution should be used to avoid breathing dust that may be generated when handling components containing asbestos fibers. If this dust is inhaled, it can be hazardous to your health. Components in DOOSAN products that may contain asbestos fibers are brake pads, brake band and lining assemblies, clutch plates and some gaskets. The asbestos used in these components is usually bound in a resin or sealed in some way. Normal handling is not hazardous as long as airborne dust which contains asbestos is not generated.

If dust which may contain asbestos is present, there are several common sense guidelines that should be followed.

- a. Never use compressed air for cleaning.
- b. Avoid brushing or grinding of asbestos containing materials.
- c. For clean up, use wet methods or a vacuum equipped with a high efficiency particulate air (HEPA) filter.
- d. Use exhaust ventilation on permanent machining jobs.
- e. Wear an approved respirator if there is no other way to control the dust.
- f. Comply with applicable rules and regulations for the work place (for example in the U.S.A., OSHA requirements as set forth in 29 CFR 1910. 1001).
- g. Follow environmental rules and regulations for disposal of asbestos.
- h. Avoid areas where asbestos particles may be in the air.

SB2004E00

Specifications

TORQUE SPECIFICATIONS

STANDARD TORQUE FOR METRIC FASTENERS

NOTE : Take care to avoid mixing metric and inch dimensioned fasteners. Mismatched or incorrect fasteners can result in vehicle damage or malfunction, or possible injury. Exceptions to these torques are given in the Service Manual where needed.

NOTE : Prior to installation of any hardware, be sure components are in near new condition. Bolt and nut threads must not be worn or damaged. Hardware must be free of rust and corrosion. Clean hardware with a non-corrosive cleaner and apply engine oil to threads and bearing face. If thread lock or other compounds are to be applied, do not apply engine oil.

METRIC NUTS AND BOLTS					
THREAD SIZE	STANDARD TORQUE				
(mm)	(N • m)	(lb • ft)			
M6	12 ± 3	9 ± 2			
M8	28 ± 7	20 ± 5			
M10	55 ± 10	40 ± 7			
M12	100 ± 20	75 ± 15			
M14	160 ± 30	120 ± 22			
M16	240 ± 40	175 ± 30			
M20	460 ± 60	340 ± 44			
M24	800 ± 100	600 ± 75			
M30	1600 ± 200	1200 ± 150			
M36	2700 ± 300	2000 ± 225			

METRIC TAPERLOCK STUDS				
THREAD	STANDARD TORQUE			
(mm)	(N • m)	(lb • ft)		
M6	8 ± 3	6 ± 2		
M8	17 ± 5	13 ± 4		
M10	35 ± 5	26 ± 4		
M12	65 ± 10	48 ± 7		
M16	110 ± 20	80 ± 15		
M20	170 ± 30	125 ± 22		
M24	400 ± 60	300 ± 45		
M30	650 ± 80	480 ± 60		
M36	870 ± 100	640 ± 75		

STANDARD TORQUE FOR INCH FASTENERS

INCH NUTS AND BOLTS				
THREAD SIZE	STANDARD TORQUE			
inch	(N • m)	(lb • ft)		
1/4	12 ± 3	9 ± 2		
5/16	25 ± 6	18.0 ± 4.5		
3/8	47 ± 9	35 ± 7		
7/16	70 ± 15	50 ± 11		
1/2	105 ± 20	75 ± 15		
9/16	160 ± 30	120 ± 20		
5/8	215 ± 40	160 ± 30		
3/4	370 ± 50	275 ± 35		
7/8	620 ± 80	460 ± 60		
1	900 ± 100	660 ± 75		
1-1/8	1300 ± 150	950 ± 100		
1-1/4	1800 ± 200	1325 ± 150		
1-3/8	2400 ± 300	1800 ± 225		
1-1/2	3100 ± 350	2300 ± 250		

Exceptions to these torques are given in the Service Manual where needed.

INCH TAPERLOCK STUDS				
THREAD SIZE	STANDARD TORQUE			
inch	(N • m)	(lb • ft)		
1/4	8 ± 3	6 ± 2		
5/16	17 ± 5	13 ± 4		
3/8	35 ± 5	26 ± 4		
7/16	45 ± 10	33 ± 7		
1/2	65 ± 10	48 ± 7		
5/8	110 ± 20	80 ± 15		
3/4	170 ± 30	125 ± 22		
7/8	260 ± 40	190 ± 30		
1	400 ± 60	300 ± 45		
1-1/8	500 ± 70	370 ± 50		
1-1/4	650 ± 80	480 ± 60		
1-3/8	750 ± 90	550 ± 65		
1-1/2	870 ± 100	640 ± 75		

O-RING FACE SEAL FITTINGS



STRAIGHT THREAD O-RING FITTING (FOR O-RING FACE SEAL FITTING ONLY)

THREAD SIZE	STANDARD TORQUE		
inch	(N • m)	(lb • ft)	
5/16-24	5.0 ± 1.5	45 ± 15 lb• in	
3/8-24	12 ± 2	110 ± 20 lb• in	
7/16-20	20 ± 4	15 ± 3	
1/2-20	30 ± 5	22 ± 4	
9/16-18	40 ± 5	30 ± 4	
3/4-16	100 ± 15	75 ± 10	
7/8-14	135 ± 15	100 ± 10	
1 1/16-12	200 ± 25	150 ± 20	
1 3/16-12	250 ± 25	185 ± 20	
1 5/16-12	300 ± 40	225 ± 30	
1 5/8-12	300 ± 40	225 ± 30	
1 7/8-12	300 ± 40	225 ± 30	
2 1/2-12	300 ± 40	225 ± 30	

O-RING FACE SEAL FITTING NUT				
THREAD SIZE	STANDARD TORQUE			
inch	(N • m)	(lb • ft)		
9/16-18	16 ± 3	12 ± 2		
11/16-16	30 ± 4	22 ± 3		
13/16-16	50 ± 7	37 ± 5		
1-14	90 ± 10	65 ± 7		
1 3/16-12	120 ± 15	90 ± 10		
1 7/16-12	160 ± 20	120 ± 15		
1 11/16-12	190 ± 20	140 ± 15		
2-12	215 ± 25	160 ± 20		

FITTING INSTALLATION

HYDRAULIC LINE INSTALLATION

- **1.** For a metal tube to hose installation, install the tube and tighten all bolts finger tight.
- 2. Tighten the bolts at the rigid end.
- 3. Install the hose and tighten all bolts finger tight.
- **4.** Put the hose in a position so that it does not make contact with the machine or another hose.
- 5. Tighten the bolts on both connections.
- 6. Start the engine.
- 7. Move the implement control levers to all positions.
- **8.** Look at the hose during movement of the implement. Make sure hose is not in contact with the machine or other hoses.
- 9. Shut off the engine.
- **10.** If necessary, put the hose in a new position where it will not make contact when the implement is moved.

ASSEMBLY OF FITTINGS WITH STRAIGHT THREADS AND O-RING SEALS

This type of fitting is used in many applications. The tube end of the fitting will be different in design so that it can be used in many different applications. However, the installation procedure of the fitting is the same. If the tube end of the fitting body is the same as in the illustration (either an elbow or a straight body) it will be necessary to assemble the sleeve on the tube before connecting the tube to the end.



End of fitting body (connects to tube). (2) Fitting body.
 Lock-nut. (4) Backup washer. (5) O-ring seal. (6) End of fitting that goes into other part.

- 1. Put locknut (3), backup washer (4) and O-ring seal (5) as far back on fitting body (2) as possible. Hold these components in this position. Turn the fitting into the part it is used on until backup washer (4) just makes contact with the face of the part it is used on.
- **2.** To put the fitting assembly in its correct position, turn the fitting body (2) out (counterclockwise) a maximum of 359°. Tighten locknut (3) to the torque shown in the correct chart for the fitting used.

NOTE: If the fitting is a connector (straight fitting), the hex on the body takes the place of the locknut. To install this type fitting, tighten the hex against the face of the part it goes into.

TORQUES FOR FLARED AND O-RING FITTINGS

The torques shown in the charts that follow are to be used on the nut part of 37° Flared, 45° Flared and Inverted Flared fittings (when used with steel tubing), O-ring plugs, O-ring fittings and swivel nuts when used in applications to 3000 psi (20 700 kPa).

HOSE CLAMP-BAND TYPE



IDAS003B

CLAMP WIDTH	TORQUE ON NEW HOSE	RETIGHTENING TORQUE
7.9 mm	0.9 ± 0.2 N•m	0.7 ± 0.2 N•m
(.312 in)	8 ± 2 lb•in	6 ± 2 lb • in
13.5 mm	4.5 ± 0.5 N•m	3.0 ± 0.5 N • m
(.531 in)	40 ± 5 lb•in	25 ± 5 lb • in
15.9 mm	7.5 ± 0.5 N•m	4.5 ± 0.5 N • m
(.625 in)	65 ± 5 lb•in	40 ± 5 lb • in

37° FLARED AND STRAIGHT THREAD O-RING FITTINGS



37° FLARED AND STRAIGHT THREAD O-RING FITTINGS (EXCEPT O-RING FACE SEAL FITTINGS)					
NOMINAL TUBE O.D.		THREAD	THREAD STANDARD TORQUE	D TORQUE	
METRIC	INCH	inch	(N • m)	(lb • ft)	
3.18	.125	5/16	5.0 ± 1.5	4 ± 1	
4.76	.188	3/8	11.0 ± 1.5	8 ± 1	
6.35	.250	7/16	16 ± 2	12 ± 1	
7.94	.312	1/2	20 ± 5	15 ± 4	
9.52	.375	9/16	25 ± 5	18 ± 4	
9.52	.375	5/8	35 ± 5	26 ± 4	
12.70	.500	3/4	50 ± 7	37 ± 5	
15.88	.625	7/8	65 ± 7	48 ± 5	
19.05	.750	1-1/16	100 ± 10	75 ± 7	
22.22	.875	1-3/16	120 ± 10	90 ± 7	
25.40	1.000	1-5/16	135 ± 15	100 ± 11	
31.75	1.250	1-5/8	180 ± 15	135 ± 11	
38.10	1.500	1-7/8	225 ± 15	165 ± 11	
50.80	2.000	2-1/2	320 ± 30	240 ± 22	

TIGHTENING OTHER FITTINGS

Hi Duty (Shear sleeve) Tube Fittings

After tube has been put through the nut and makes contact against the tube shoulder in the fitting body, turn the nut with a wrench until a small decrease in torque is felt. This is an indication that the sleeve has been broken off the nut. Hold the tube to prevent turning and tighten the nut 1-1/2 turns.

Hi Seal Fittings

Put nut and sleeve over the tubing with the short heavy end of the sleeve facing the end of tubing. Put the tube end against the counterbore in the body of the fitting and tighten until nut is over the last thread on the body. The remainder of space is used whenever the fitting is removed and installed again.





45° FLARED AND 45° INVERTED FLARE FITTINGS



45° FLARED AND 45° INVERTED FLARE FITTINGS					
NOMINAL TUBE O.D.			STANDARD TORQUE		
METRIC	INCH	inch	(N • m)	(lb • ft)	
3.18	.125	5/16	5.0 ± 1.5	4 ± 1	
4.76	.188	3/8	8.0 ± 1.5	6 ± 1	
6.35	.250	7/16	11 ± 2	8 ± 1	
7.94	.312	1/2	17 ± 3	13 ± 2	
9.52	.375	5/8	30 ± 3	22 ± 2	
11.11	.438	11/16	30 ± 3	22 ± 2	
12.70	.500	3/4	38 ± 4	28 ± 3	
15.88	.625	7/8	50 ± 5	37 ± 4	
19.05	.750	1-1/16	90 ± 8	65 ± 6	
22.22	.875	1-1/4	100 ± 10	75 ± 7	

TIGHTENING OTHER FITTINGS

Ermeto Tube Fittings

Put nut and sleeve over the tube with head or shoulder end of sleeve next to nut. Push tube into counterbore of fitting body as far as possible. Turn nut clockwise until sleeve holds tube and prevents movement. Tighten the nut 1-1/4 turns more to seat sleeve and give a locking action. When necessary to assemble again, put sleeve over tube and tighten nut until a sudden increase in torque is felt. Then tighten 1/6 to 1/3 turn more to seat the sleeve.

Flex Fittings

Put nut and sleeve over the tubing and push tube in to counterbore of fitting body as far as possible. Tighten the nut until it is against the hex part of the fitting body.





AIR CONDITIONING AND TAPERED PIPE THREAD FITTINGS



AIR CONDITIONING FITTINGS						
O-RING FITTING END 45° FLARE FITTING END						
THREAD			STEEL TUBES ALUMINUM TUBES			
SIZE	STANDAR	D TORQUE	STANDARD TORQUE		STANDARD TORQUE	
inch	N • m	(lb • ft)	N • m	(lb • ft)	N • m	(lb • ft)
5/8-18	18 ± 4	13 ± 3	30 ± 3	22 ± 2	23 ± 3	17 ± 2
3/4-16	37 ± 4	27 ± 3	52 ± 5	38 ± 4	33 ± 4	24 ± 3
7/8-14	40 ± 4	30 ± 3	60 ± 7	44 ± 5	38 ± 4	28 ± 3
1 1/16-14	45 ± 5	33 ± 4	75 ± 8	55 ± 6	50 ± 5	37 ± 4

TAPERED PIPE THREAD FITTINGS					
PIPE		STANDARD TORQUE			
THREAD	THREAD 1E2200E	DS WITH SEALANT	THREADS WITHOUT SEALANT		
inch	N•m	(lb • ft)	N•m	(lb • ft)	
1/16-27	15	11	20	15	
1/8-27	20	15	25	18	
1/4-18	25	18	35	26	
3/8-18	35	26	45	33	
1/2-14	45	33	60	45	
3/4-14	60	45	75	55	
1-11 1/2	75	55	90	65	
1 1/4-11 1/2	95	70	110	80	
1 1/2-11 1/2	110	80	130	95	
2-11 1/2	130	95	160	120	

Specifications Systems Operation Testing & Adjusting

LPG Engine Hercules 2.7 Liter GC15, GC18, GC20C

SB2171E00 Feb. 1999

Specifications Systems Operation Testing & Adjusting

LPG Engine Hercules 2.7 Liter GC15, GC18, GC20C

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Read and understand all safety precautions and warnings before operating or performing lubrication, maintenance and repair on this product.

Basic safety precautions are listed in the "Safety" section of the Service or Technical Manual. Additional safety precautions are listed in the "Safety" section of the owner/operation/maintenance publication. Specific safety warnings for all these publications are provided in the description of operations where hazards exist. WARNING labels have also been put on the product to provide instructions and to identify specific hazards. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons. Warnings in this publication and on the product labels are identified by the following symbol.

A WARNING

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

DAEWOO cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by DAEWOO is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. DAEWOO dealers have the most current information available.

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Specifications

Ignition Timing



The correct timing is when the flywheel housing pointer is in alignment with the correct mark on the flywheel or when the single digit mark on the flywheel is in alignment with the correct timing mark on the timing plate.

LP fuel engines @ 800 rpm.....14° BTC

NOTE: Engine should be at normal operating temperature when ignition timing is checked and/or adjusted.

NOTE: For engine timing accuracy, the vacuum advance hose must be disconnected from the distributor vacuum advance valve, and plugged. See Ignition Timing Check And Adjustment in the Testing And Adjusting section.

Ignition Sequence (Firing Order)



IDES002S

The firing order is 1-3-4-2.

Ignition Coil



Spark Plug And Spark Plug Wires

Sensor Gap



IDES004S

Gap for spark plugs (LP)0.89 \pm 0.05 mm $(.035 \pm .002 \text{ in})$

Torque for spark plugs36 \pm 5 N•m (26 \pm 4 lb•ft)

Resistance of spark plug

wires13 000 ohms per meter (3960 ohms per foot)

Distributor



IDES006S

Trigger wheel (2) runout not to be more than.....0.05 mm (.002 in)

Gap (X) between trigger wheel (2) and sensor (1) is0.20 mm (.008 in)

See Sensor Gap Adjustment in Testing And Adjusting.



- (1) Shaft end play ... 0.89 to 1.02 mm (.035 to .040 in)
- (2) Shaft side play not to be more than0.10 mm (.004 in)

LP Converter



IDES007S

 Turn all the screws in until contact is made with cover, then tighten screws thoroughly from one side to the opposite side until all the screws have a good seat.

With a maximum of 725 kPa (120 psi) of air put into fuelock or converter, there should be no air leaks in ten minutes.

See Converter And Vacuum Fuelock Pressure Test in the Testing and Adjusting section.

Tighten nylon vacuum fittings (not shown) finger tight plus an additional 360° (one full turn). Then turn farther to desired location.



IDES008S

Resistance of solenoid could have a range of $8 \sim 18$ ohms.

Carburetors

Low Idle Setting



LP

(1) Adjust low idle speed to 800 \pm 50 RPM.

Power Mixture Setting





High idle speed......2375 $\pm~$ 50 rpm

To adjust high idle; hold center screw (2) from turning, turn wheel (1) to change the high idle speed.

NOTE: Clockwise rotation of wheel (1) increases engine speed. Counterclockwise rotation of wheel (1) decreases engine speed.



- (1) Adjust power mixture to "MID" (Center). This is a starting point.
- (2) Tighten nylon vacuum fitting finger tight plus an additional 360° (one full turn). Then turn farther to desired location.

See Carburetor Adjustments of the Liquid Petroleum Fuel System in the Testing and Adjusting section. For final setting of power mixture.

Oil Pan



- (1) Put silicone RTV sealant on oil pan front and rear seals.
- (2) Torque for six bolts12 to 16 N·m (9 to 12 lb·ft)
- (3) Torque for twelve bolts4 to 5 N·m (36 to 48 lb·ft)
- (4) Torque for plug15 to 25 N·m (20 to 34 lb·ft)

Oil Filter



- (1) Wipe clean the filter adapter in the area that the new filter makes contact. Put clean engine oil on the new filter gasket. Install filter until contact is made, then tighten 3/4 turn more.
- (2) Put LOCTITE NO.242 Thread Lock on stud, torque for stud is70 \pm 7 N·m (50 \pm 5 lb·ft)

Oil Pump



IDES017S

(1) Oil pressure valve controlled oil pressure37 to 50 psi (260 to 350 Kpa) Spring (oil pressure relief):

Length under test force	35.6 mm (1.40 in)
Test force	7.5 to 8.0 LB
Free length after test	. 55.4 mm (2.18 in)
Outside diameter	9.4 mm (.37 in)

- (3) Depth of gears from pump body surface is0.05 to 0.25 mm (.002 to .005 in)
- (5) Idler and drive shaft depth inside gears0.0 to 0.25 mm (.000 to .010 in)

Manifolds



- Put Anti-Seize Compound on the manifold bolts. Tighten inlet manifold (2) and exhaust manifold (1) bolts at the center bolts first, then in sequence to the end bolts.
- (3) Torque for exhaust manifold bolts......30 to 35 lb•ft (41 to 47 N•m)

NOTE: Current Models with LP fuel systems use bolts A and B to mount the LP Converter bracket and use the same mounting bolt procedure.

Rocker Arms And Valve Lifters



- (1) Torque bolts and nuts that hold rocker arms45 to 55 N·m (35 to 40 lb•ft)

Valves



(1) Exhaust valve:

Diameter of valve stem	7.856 \pm .008 mm
	$(.30930 \pm .0003 \text{ in})$

"Use Again" diameter of valve stem7.82 mm (.308 in)
Minimum permissible diameter of valve stem (worn)7.785 mm (.3065 in)
Length of exhaust valve111.76 \pm 0.13 mm (4.400 \pm .005 in)
Bore in cylinder head7.925 \pm .013 mm (.3120 \pm .0005 in)
Maximum permissible bore in head for valve7.988 mm (.3145 in)
(2) Intake valve: Diameter of valve stem7.880 \pm 0.005 mm (.3102 \pm .0002 in)
"Use Again" diameter of valve stem7.85 mm (.309 in)
Minimum permissible diameter of valve stem (worn)7.818 mm (.3078 in)
Length of intake valve
Bore in cylinder head
Maximum permissible bore in head for valve7.963 mm (.3135 in)

(3)	7N7713 Spring for valve: Length under test force47.24 mm (1.860 in) Test force195 N (43.8 lb) Free length after test53.3 mm (2.10 in) Outside diameter35.6 mm (1.40 in) Length of spring at valve open position
(4)	Minimum permissible thickness of lip of valves: Exhaust valve1.73 mm (.068 in) "Use Again" thickness1.93 mm (.076 in) Intake valve1.37 mm (.054 in) "Use Again" thickness1.65 mm (.065 in)
(5)	Diameter of valve head: Exhaust valve37.59 \pm 0.13 mm (1.55 \pm .005 in) Intake valve45.97 \pm 0.13 mm (1.810 \pm .005 in)
(6)	Angle of valve face: Intake valve



A75078P2

- (7) Dimension from top of closed valve to face of head :.....13.82 \pm 0.25 mm (.544 \pm .010 in) Intake valve dimension14.76 \pm 0.38 mm
- (9) Maximum permissible width of seat face of valve seat: Exhaust valve2.90 mm (.114 in) Intake valve2.0 mm (.08 in)
- Minimum permissible width of seat face of valve seat : Exhaust valve2.34 mm (0.092 in) Intake valve1.78 mm (.07 in)
- (10) Angle of face of exhaust valve seat insert......30°



A76696P1

- (12) Depth of bore in head for exhaust valve seat insert......6.30 to 6.65 mm (.248 to .262 in)



C30834P1

NOTE: Current cylinder heads have removable bronze liners (13) in the exhaust valve gide. Liner (13) can be replaced and then reamed for new valves.

Camshaft



- (1) Press fit between the gear and camshaft 001 to .003 in
- (2) Thrust plate:

Thickness (new)..4.8 \pm 0.03 mm (.189 \pm .001 in) End play for the camshaft.....0.08 to 0.18 mm (.003 to .007 in) Maximum permissible end play (worn)....0.28 mm (.011 in)

(3) Journals:

Diameter of the surfaces (journals) for the camshaft bearings (new).......51.03 to 51.05 mm (2.009 to 2.010 in) Bore in the three bearings for the camshaft (new).......51.079 to 51.092 mm (2.0110 to 2.0115 in) Clearance between bearing and bearing surface (journal)......0.03 to 0.064 mm (.001 to .0025 in)

Maximum permissible clearance between bearing and bearing surface (journal) (worn)0.114 mm (.0045 in)



- (4) Height of camshaft lobes.
- To find lobe lift, use the procedure that follows:
- A. Measure camshaft lobe height (6).
- **B.** Measure base circle (8).
- **C.** Subtract base circle (Step B) from lobe height (Step A). The difference is actual lobe lift (7).
- **D.** Specified camshaft lobe lift is: Exhaust lobe6.78 \pm 0.03 mm (.267 \pm .001 in) Intake lobe.......6.78 \pm 0.03 mm (.267 \pm .001 in)

Maximum permissible difference between actual lobe lift (Step C) and specified lobe lift (Step D) is.....0.25 mm (.010 in)



NOTE: For installation of camshaft assembly, the timing mark (A) on the camshaft gear teeth must be in alignment with the timing mark (B) on the tooth of the crankshaft gear.

Valve And Block Cover



IDES026S

- (2) Torque for screws that hold cover to block is.....4.1 to 5.5 N•m (36 to 48 lb•in)

Timing Gears



IDES027S

- (1) Outside diameter of camshaft gear143.15 \pm 0.05 mm (5.636 \pm .002 in)

Timing Gear Backlash:

Camshaft gear (1) to crankshaft gear (2).....0.06 to 0.14 mm (.0025 to .0057 in)

See Timing Gear Backlash Check in the Testing And Adjusting section.

Pistons And Rings



- Clearance between top ring and groove0.076 mm (.003 in) Maximum permissible clearance0.20 mm (.008 in)
- (3) A tight fit between oil ring assembly and groove.
 Maximum permissible clearance0.13 mm (.005 in)

NOTE: Piston ring kits are available in 0.51 mm (.020 in) and 1.02 mm (.040 in) oversize (larger than the original size). See Cylinder Block, Cylinder bore specifications.

Clearance between ends of piston ring installed in the part of the cylinder bore that has no wear.

(4) Top ring:

Clearance between ends of piston		
.0.25 to 0.51 mm (.010 to .020 in)		
Maximum permissible clearance		
0.64 mm (.025 in)		

(5) Center ring:

Clearance between ends of piston ring......0.25 to 0.51 mm (.010 to .020 in) Maximum permissible clearance (worn).....0.64 mm (.025 in)

 (6) Oil ring assembly:
 Clearance between outer ring ends of piston ring......0.25 to .76 mm (.010 to .030 in) **NOTE:** When piston rings are installed, put them in position so that the ring ends are 120° apart.

(7) Original piston pin:

Pin diameter	24.768 to 24.770 mm	
	(.9751 to .9752 in)	
Bore in piston for pin	24.773 to 24.778 mm	
	(.9753 to .9755 in)	
Clearance between pin a	and bore in	
piston0.000 to 0.01	0 mm (.0000 to .0004 in)	
Maximum permissible clearance		
(worn)	0.018 mm (.0007 in)	

Connecting Rods



(1) Original piston pin: Bore in bearing for pin......24.773 to 24.780 mm (.9753 to .9756 in)

Maximum permissible bore (worn)24.818 mm (.9771 in) Clearance between piston pin and connecting rod .0001/.005 bearing bore0.003 to 0.013 mm(.0001 to .0005 in) Maximum permissible clearance0.018 mm (.0007 in)

- (2) Bore in connecting rod for bearing with nuts (4) tightened to specification......53.965 $\pm\,$ 0.010 mm (2.1246 $\pm\,$.0004 in)
- (3) Distance between center of piston pin and center of crankshaft bearing......138.2 \pm .5 mm (5.44 \pm .02 in)

NOTE: Assemble connecting rod and cap with identification marks on the same side and on the camshaft side.

Cylinder Head



IDES030S

Maximum permissible amount of bow (out of flat) per 152 mm (6 in):

Across width (transverse)......0.05 mm (.002 in) Across length (longitudinal).....0.05 mm (.002 in) Maximum permissible amount of bow (out of flat) per full length0.10 mm (.004 in)

See Cylinder Head Check in the Testing And Adjusting section.

Cylinder Head Torque Procedure:

Perform the following when installing the cylinder head:

- •Install a new cylinder head gasket.
- •Put engine oil or Molykote Paste Lubrication on the cylinder head bolt threads before installation.
- •Tighten the cylinder head bolts according to the following proper procedure.
- Tighten the bolts in number sequence to a torque of70 ± 7 N·m (50 ± 5 lb·ft)
- 3. Check and adjust valve clearance as needed.

Crankshaft



Torque for crankshaft pulley

bolt115 \pm 7 N·m (85 \pm 5 lb·ft)

- (1) Front seal. Put oil on lip of seal and install seal with lip to the inside.
- (2) Crankshaft gear: Maximum temperature the gear can be heated to, when installing on the crankshaft.....204°C (400°F) Press Fit between crankshaft gear and the crankshaft0.013 to 0.038 mm (.0005 to .0015 in)
- (3) Main journals:

Clearance between main bearing and crankshaft bearing surface (journal).....0.023 to 0.089 mm (.0009 to .0035 in) Maximum permissible clearance between main

bearing and crankshaft bearing surface (journal)0.127 mm (.005 in)

Maximum permissible run out (axial eccentricity) of the crankshaft, measured at the center main bearing surface (journal).....0.08 mm (.003 in)

Maximum permissible run out (axial eccentricity) of the crankshaft measured at No.1 and No.3 main bearing surfaces (journal).....0.08 mm (.003 in)

Diameter of bearing surface; original size57.092 to 57.112 mm (2.2477 to 2.2485 in) Minimum permissible diameter (worn)57.015 mm (2.2447 in)

Diameter of bearing surface; undersized 0.25 mm (.010 in)......56.838 to 56.858 mm (2.2377 to 2.2385 in) Minimum permissible diameter (worn)....56.761 mm (2.2347 in) Diameter of bearing surface; undersized 0.50 mm (.020 in)......56.584 to 56.604 mm (2.2277 to 2.2285 in) Minimum permissible diameter (worn)56.507 mm (2.2247 in) Diameter of bearing surface; undersized 0.76 mm (.030 in)......56.330 to 56.350 mm (2.2177 to 2.2185 in) Minimum permissible diameter (worn)56.253 mm(2.2147 in) (4) Rear seal. Put oil on lip of seal and install seal with lip to the inside. (5) Connecting rod journal: Clearance between rod bearing and crankshaft bearing surface (journal).....0.033 to 0.079 mm (.0013 to .0031 in) Diameter of bearing surface; original size.....50.747 to 50 767 mm (1.9979 to 1.9987 in) Minimum permissible diameter (worn)50.696 mm (1.9959 in) Diameter of bearing surface; undersized 0.25 mm (.010 in)......50.493 to 50.513 mm (1.9879 to 1.9887 in) Minimum permissible diameter (worn)50.442 mm (1.9859 in) Diameter of bearing surface; undersized 0.51 mm (.020 in)......50.239 to 50.259 mm (1.9779 to 1.9787 in) Minimum permissible diameter Diameter of bearing surface; undersized 0.76 mm (.030 in)......49.985 to 50.005 mm (1.9679 to 1.9687 in) Minimum permissible diameter (worn) 49.934 mm (1.9659 in) (6) End play of the crankshaft.....0.10 to 0.23 mm (.004 to .009 in) Maximum permissible end play for the crankshaft (worn)0.33 mm (.013 in)

NOTE: Thrust bearing at center main bearing.

(7) Maximum length of pin, protruding out of crankshaft face......7.9 \pm 1.3 mm (.31 \pm .05 in)

NOTICE

Rear main bearing cap and the engine block have four rear oil seals (not shown) between the engine block and the bearing cap. Install seals carefully and fit correctly in grooves of bearing cap so no oil leaks out.

NOTE: Do not trim (cut) on the seals. The seals give a tight fit.

Cylinder Block



NOTE: Measure wear of the cylinder bore at the top and bottom of piston ring travel.

(1) Cylinder, original size: Bore...101.605 $\pm\,$ 0.015 mm (4.0002 $\pm\,$.0006 in)

The recommendation is made to make the Cylinder bore the next size larger when the bore is......101.73 mm (4.005 in)

Cylinder bore must be made the next size larger when the bore is.....101.78 mm (4.007 in)

(1) Cylinder, oversized 0.51 mm (.020 in): Bore...102.113 $\pm\,$ 0.015 mm (4.0202 $\pm\,$.0006 in)

The recommendation is made to make the cylinder bore the next size larger when the bore is......102.24 mm (4.025 in)

Cylinder bore must be made the next size larger when the bore is.....102.29 mm (4.027 in)

(1) Cylinder, oversized 1.02 mm (.040 in): Bore...102.621 \pm 0.015 mm (4.0402 \pm .0006 in)

Maximum permissible bore of cylinder (replacement of the cylinder block is necessary)102.79 mm (4.047 in)

- (2) Length of dowels (two) out of the top surface of the cylinder block......6.1 mm (.24 in)

NOTE: Dimension(X) from center line of crankshaft to the piston cylinder center line as viewed from the rear of the cylinder block is1.52 mm (.060 in) to the left.

- (4) Dimension (new) from top of cylinder block to bottom of cylinder block......239.85 to 239.95 mm (9.443 to 9.447 in)

Install the middle camshaft bearing to a dimension from front surface of engine block of229.87 mm (9.050 in)

Install the rear camshaft bearing to a dimension from the front surface of the engine block of459.74 mm (18.100 in)

NOTICE

Make sure the oil holes in the bearings are in alignment with the oil holes in the block.

- (6) Length of dowel protruding out of the front surface of the cylinder block.......22.1 mm (.87 in) Length of dowel (not shown) out of the rear surface of the cylinder block.......9.7 mm (.38 in)
- (7) Width of the center main bearing cap114.76 to 114.78 mm (4.518 to 4.519 in)Width of the center main bearing cap guide (in

Install five cup plugs (freeze plugs) (not shown) so that they are recessed into the engine block surface a minimum of0.8 mm (.03 in)

Flywheel Housing

Flywheel Housing Runout

For checking procedure, see Flywheel And Flywheel Housing in the Testing And Adjusting section

Face Runout (Axial Eccentricity)



IDES034S

Face Runout Check

Maximum permissible face runor	ut of the flywheel
housing	0.13 mm (.005 in)



IDES033S

(1) Torque for bolts in number sequence55 to 60 N·m (40 to 45 lb·ft)

NOTE: Current Models have a rear plate instead of a flywheel housing.

Flywheel



- (1) Install ring gear with tooth chamfer opposite shoulder. Maximum temperature for installation.......185°C (365°F)
- (2) Maximum permissible change from an exact vertical face (runout) during one rotation (total indicator reading)0.13 mm (.005 in)
- (3) Apply LOCTITE NO. 242 Thread Lock to bolt threads.
 Torque for the bolts that hold the flywheel to the crankshaft110 ± 7 N·m (80 ± 5 lb·ft)
- (4) Maximum permissible change in distance from center of bore (eccentricity) during one rotation (total indicator reading)0.13 mm (.005 in)

Flywheel Runout

For checking procedure, see Flywheel And Flywheel Housing in the Testing And Adjusting section.

Face Runout (Axial Eccentricity)



IDES036S

Face Runout Check

Maximum permissible face runou	t of the
flywheel	0.13 mm (.005 in)

Outside Diameter Runout (Radial Eccentricity)



IDES037S

Outside Diameter Runout Check

Maximum permissible outside diameter runout of the flywheel.....0.13 mm (.005 in)

Belt Tension



The 12.7 mm (1/2 in) alternator (fan) belt should be adjusted using a Borroughs Tool Gauge No.BT-33-97 or BT-33-95 (older).

Readjust tension of new belt after 30 minutes of operation to265 $\pm\,$ 20 N (60 $\pm\,$ 5 lb)

Gauge reading; used belt265 \pm 20 N (60 \pm 5 lb)

Engine Mount Groups



(1) Torque for front engine mount bolts25 \pm 7 N·m(18 ± 5 lb·ft)

Water Pump



IDES040S

(1) Assemble impeller on pump housing shaft until clearance is.....0.38 to 0.89 mm (.015 to .035 in)

NOTE: Put Sealer on the water pump bolts and tighten them evenly to 17 to 21 lb•ft.

Pressure Caps

Water Temperature Regulator (Thermostat)



Opening temperature80 to 84 °C (176 to 184 °F)

Full open temperature......94 °C (202 °F)

For testing procedure, see Cooling System Tests in the Testing And Adjusting section.



IDES041S

For testing procedure, see Cooling System Tests in the Testing And Adjusting section.

D460972

Pressure valve must start to open85 to 110 kPa (12.3 to 16 psi)

Vacuum valve must open (maximum) (below atmospheric pressure)5.0 kPa (.73 psi)

Alternators

For complete alternator specifications, see the Alternator Coverage chart for the correct Service Module.

ALTERNATOR COVERAGE		
Alternator	Manufacturer/	
Part Number	Series	
D700328	Delco Remy/CS-121	

Delco Remy CS-121 Series

Starting Motors

For complete specifications on the starting motors, see the Starting Motor Coverage chart for the correct Service Module.

STARTING MOTOR COVERAGE		
Starting Motor Part Number	Manufacturer/ Series	
A250115	Delco Remy/ Reduction	



D700328-Delco Remy Number 1101291

Rated voltage12 volts
Polarity is negative ground.
Rotation is clockwise.
Output at 6500 rpm (cold)61 amps
Output voltage14.0 \pm 0.5 volts
(1) Torque for battery terminal nut3.6 \pm 0.8 N·m (32 \pm 7 lb·in)
(2) Torque for pulley nut100 \pm 7 N·m (75 \pm 5 lb·ft)

Systems Operation

General Information

of the engine.

Bore	102 mm (4.00 in)	
Stroke	83 mm (3.25 in)	
Cubic Capacity	2671 cc (163 in ³)	
Number and Arrangement of G	Cylinders1-4 1-3-4-2	
Rotation of Crankshaft (when front)	seen from Clockwise	
Rotation of Camshaft (when seen from front)Counterclockwise		
NOTE: Front end of engine is opposite to flywheel end. Left side and right side of engine are as seen from flywheel end. No.1 cylinder is the front cylinder		

Ignition System

Breakerless Ignition System



Ignition System Schematic (1) Battery. (2) Ignition switch. (3) Coil. (4) Distributor. (5) Spark Plug.



Distributor Components (6) Sensor. (7) Trigger wheel.

The ignition system has battery (1), ignition switch (2), coil (3), distributor (4) with inner electronics circuits and spark plugs (5). The battery and ignition switch have terminals and closed contacts to permit battery current flow through the ignition system. These components must have closed current connections to complete the operation of the ignition circuit. Coil (3) and spark plugs (5) are of the standard type. The ignition coil changes the low

voltage current into high voltage current to make a spark at the gap of the spark plug. The coil has two windings around a soft iron core. The primary has a small number of turns of heavy wire, and the secondary has many thousand turns of a very fine wire. The primary winding is on the outside of the secondary windings. The distributor has a sensor (6), trigger wheel (7) with lobes and the electric circuit that is a sealed unit inside the bottom of the distributor housing. Thanks for your reading.

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