

Product: Case 300 and 400 Series Diesel Engines Service Manual

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300 and 400 Series Diesel Engines and Fuel Systems

Service Manual

GSS1427B

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Reprinted

CASE

Due to a continuous program of research and development, some procedures, specifications and parts may be altered in a constant effort to improve our products.

When changes and improvements are made in our products, periodic revisions may be made to this manual to keep it up-to-date. It is suggested that customers contact their dealer for information on the later revision.

**300 and 400 Series Diesel
Engines and Fuel Systems
(U.D.T.S. – formerly American Bosch)
(Robert Bosch)**

**GSS-1427-B W/Revision 1
June, 1984**



CAUTION: Some photographs in this manual may show shields or cover panels removed for purposes of clarity. **NEVER OPERATE** Unit without all shields and cover panels in place.

General Contents

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Section **1** ENGINE

Section **2** FUEL SYSTEM

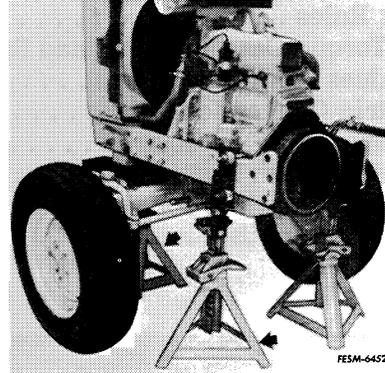
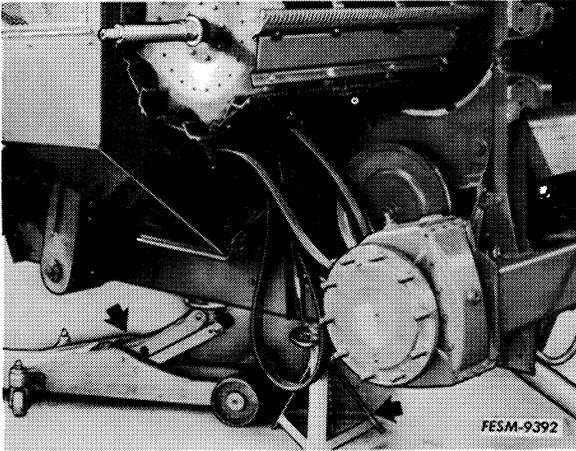
Section **3** TURBOCHARGER

WORK SAFELY – FOLLOW THESE RULES

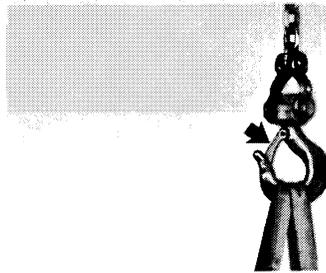


This symbol is used to call your attention to instructions concerning your personal safety. Be sure to observe and follow these instructions.

1. To prevent injury, do not allow children or by-standers around the machine while it is being adjusted and/or serviced.



8. When splitting tractors, or disassembling machines, be sure to use safety stands and adequate supports to prevent tipping or rollover.



2. Always use safety stands in conjunction with hydraulic jacks or hoists. Do not rely on the jack or hoist to carry the load, they could fail.

3. Articulated Tractors – Always use the frame lock pin when servicing the tractor in the area of the hinged or pivot point of the frame. The lock pin must be in place when making adjustments with the engine running. The lock pin prevents accidental pivoting of the frame. Always remove the lock pin and store correctly before attempting to steer the tractor.

4. Always wear safety glasses when using a hammer, chisel or other tools that may cause chips to fly.

5. Keep work area organized and clean. Wipe up oil or spills of any kind. Keep tools and parts off of the floor. Eliminate the possibility of a fall which could result in a serious injury.

6. Be sure to reinstall safety devices, guards or shields after adjusting and/or servicing the machine. Also, replace missing or damaged safety and/or instruction decals.

7. After servicing, be sure all tools, parts, or servicing equipment are removed from the machine.

9. Use a safety catch on all hoist hooks. Do not take a chance, the load could slip off of the hook.



10. When using an acetylene torch always wear welding goggles and gloves. Keep a "charged" fire extinguisher within reach. Be sure the acetylene and oxygen tanks are separated by a metal shield and are chained to the cart. Do not weld or heat areas near fuel tanks or fuel lines and utilize proper shielding around hydraulic lines.



11. Always use a safety bar to block hydraulic cylinders. Never rely on the machine hydraulic system to hold when working on loaders, etc. A hydraulic line or cylinder could fail or someone could accidentally strike the control levers causing the loader to fall.

12. Electrical storage batteries give off highly inflammable hydrogen gas when charging and continue to do so for some time after receiving a steady charge. Do not under any circumstances allow an electric spark or an open flame near the battery. Always disconnect a battery cable before working on the electrical system.

13. Hydraulic fluid escaping under pressure can have enough force to penetrate the skin. Hydraulic fluid may also infect a minor cut or opening in the skin. If injured by escaping fluid, see a doctor at once. Serious infection or reaction can result if medical treatment is not given immediately.

Do not attempt to repair or tighten hoses that are under pressure, when the boom is raised, or with the tractor engine running. Cycle all hydraulic control valves to relieve all pressure before disconnecting the lines or performing other work on the hydraulic system. Make sure all connections are tight and hoses and lines are in good condition before applying pressure to the system. To locate a leak under pressure, use a small piece of cardboard or wood. Never use hands.

14. Handle gasoline with care - it is highly flammable:

- (a) Use approved gasoline container.
- (b) Never remove the fuel tank cap or fill the fuel tank when the engine is running, is hot, or indoors. Also, do not smoke when working around flammable fuel.
- (c) When refueling, keep the hose and nozzle of the funnel and container in contact with the metal of the fuel tank to avoid the possibility of an electric spark igniting the fuel. Do not overfill the fuel tank - overflow creates fire hazard. Wipe up spilled gasoline.
- (d) Replace fuel tank cap securely.

15. Always use a protective fixture when inflating tubeless tires that have been repaired or are loose on the rim. Do not inflate over 30 psi to seat the tire bead.

16. Use pullers to remove bearings, bushings, gears, cylinder sleeves, etc. when applicable. Use hammers, punches and chisels only when absolutely necessary. Then, be sure to wear safety glasses.

17. Be careful when using compressed air to dry parts. Use approved air blow guns, do not exceed 30 psi, wear safety glasses or goggles and use proper shielding to protect everyone in the work area.

18. Do not wear rings, wrist watches or loose fitting clothing when working on machinery, they could catch on moving parts causing serious injury. Wear sturdy, rough-soled work shoes. Never adjust and/or service a machine in bare feet, sandals or sneakers.

19. Excessive or repeated skin contact with sealants or solvents may cause skin irritation. In case of skin contact, remove sealant or solvent promptly by washing with soap and water.

IMPORTANT: The above is only a partial list of safe work rules. In addition, always refer to the Operator's Manual for the specific machine for additional safe work rules regarding the machine operation.

STANDARD TORQUE DATA FOR INCH NUTS AND BOLTS — FOOT POUNDS

Recommended torque for all Standard Unplated Nuts and Bolts, provided:

- A. Surface finish is oxide coated, oil quenched or bright.
- B. All thread surfaces are clean and lubricated with SAE-30 engine oil or equivalent (See NOTE.)
- C. Joints are rigid, that is, no gaskets or compressible materials are used.
- D. When reusing nuts or bolts use minimum torque values.

NOTE: Multiply the standard torque by:
 .65 when finished jam nuts are used.
 .70 when Molykote, white lead or similar mixtures are used as lubricants.
 .75 when phosphate coated and oiled bolts or nuts are used.
 .85 when cadmium or zinc dichromate bolts or nuts are used.
 .90 when hardened surfaces are used under the nut or bolt head (this applies to standard unplated hardware only).

1 FOOT POUND = 1.355 NEWTON METERS

Bolt or Stud Diameter	Type 1 Studs Only		Type 1 Bolts 6" length or less		Type 1 Bolts longer than 6"		Type 5 (all lengths)		Type 8 (all lengths)			
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Only when used † in cast (gray) iron		All other applications	
Inches									Min.	Max.	Min.	Max.
1/4	5	6	6	7	4	4	9	10	11	13	13	14
5/16	12	13	11	13	7	8	18	20	22	25	25	28
3/8	21	24	21	24	13	14	33	37	41	46	45	50
7/16	35	38	35	38	20	23	53	60	65	74	75	85
1/2	52	58	52	59	31	35	80	90	100	112	115	130
9/16	70	80	75	85	45	51	115	130	145	160	165	185
5/8	98	110	104	117	62	70	160	180	200	225	225	255
3/4	174	195	185	205	110	125	285	320	355	400	400	460
7/8	280	315	180	200	180	200	460	575	570	640	645	725
1	420	470	265	300	265	300	685	720	855	960	970	1090
1-1/8	595	670	380	425	380	425	850	950	1210	1360	1375	1545
1-1/4	840	945	535	600	535	600	1200	1350	1705	1920	1940	2190
1-3/8	1100	1240	700	785	700	785	1570	1760	2235	2515	2540	2860
1-1/2	1470	1640	925	1045	925	1045	2080	2340	2970	3340	3375	3795

†When bolt penetration is 1-1/2 times the diameter of the bolt.

BOLT TYPE IDENTIFICATION CHART

IH TYPE	S.A.E. GRADE	DESCRIPTION	BOLT HEAD MARKING*
1	1 EQUIVALENT OR 2	WILL HAVE A  STANDARD MONOGRAM IN THE CENTER OF THE HEAD Low or Medium Carbon Steel Not Heat Treated	
5	5	WILL HAVE A  AND 3 RADIAL LINES Quenched and Tempered Medium Carbon Steel	
8	8	WILL HAVE A  AND 6 RADIAL LINES Quenched and Tempered Special Carbon or Alloy Steel	

*The center marking identifies the bolt manufacturer.

STANDARD TORQUE DATA FOR INCH NUTS AND BOLTS - NEWTON METERS

Recommended torque for all Standard Unplated Nuts and Bolts, provided:

- A. Surface finish is oxide coated, oil quenched or bright.
- B. All thread surfaces are clean and lubricated with SAE-30 engine oil or equivalent (See NOTE.)
- C. Joints are rigid, that is, no gaskets or compressible materials are used.
- D. When reusing nuts or bolts use minimum torque values.

NOTE: Multiply the standard torque by:
 .65 when finished jam nuts are used.
 .70 when Molykote, white lead or similar mixtures are used as lubricants.
 .75 when phosphate coated or oiled bolts or nuts are used.
 .85 when cadmium or zinc dichromate bolts or nuts are used.
 .90 when hardened surfaces are used under the nut or bolt head (this applies to standard unplated hardware only).

1 NEWTON METER = 0.738 FOOT POUND

Bolt or Stud Diameter	Type 1 Studs Only		Type 1 Bolts 6" length or less		Type 1 Bolts longer than 6"		Type 5 (all lengths)		Type 8 (all lengths)			
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Only when used† in cast (gray) iron		All other applications	
Inches									Min.	Max.	Min.	Max.
1/4	7	8	8	9	5	5	12	14	15	18	18	19
5/16	16	18	15	18	9	11	24	27	30	34	34	38
3/8	28	33	28	33	18	19	45	50	56	62	61	68
7/16	47	52	47	52	27	31	72	81	88	100	102	115
1/2	71	79	71	80	42	47	109	122	136	152	156	176
9/16	95	109	102	115	61	69	156	176	197	217	224	251
5/8	133	149	141	159	84	95	217	244	271	305	305	346
3/4	236	265	251	278	149	170	387	434	482	543	543	611
7/8	380	427	244	271	244	271	624	780	773	868	875	984
1	570	638	360	407	360	407	929	977	1160	1303	1316	1479
1-1/8	807	909	516	577	516	577	1153	1289	1642	1845	1866	2096
1-1/4	1140	1282	726	814	726	814	1628	1832	2313	2605	2632	2958
1-3/8	1492	1682	950	1065	950	1065	2130	2388	3033	3412	3446	3881
1-1/2	1995	2225	1255	1418	1255	1418	2822	3175	4030	4532	4579	5149

†When bolt penetration is 1-1/2 times the diameter of the bolt.

BOLT TYPE IDENTIFICATION CHART

IH TYPE	S.A.E. GRADE	DESCRIPTION	BOLT HEAD MARKING*
1	1 or 2 <small>Equivalent</small>	WILL HAVE A  STANDARD MONOGRAM IN THE CENTER OF THE HEAD Low or Medium Carbon Steel Not Heat Treated	
5	5	WILL HAVE A  AND 3 RADIAL LINES Quenched and Tempered Medium Carbon Steel	
8	8	WILL HAVE A  AND 6 RADIAL LINES Quenched and Tempered Special Carbon or Alloy Steel	

*The center marking identifies the bolt manufacturer.

INTRODUCTION

TORQUE VALUES FOR HOSE CLAMPS

The following chart provides the tightening torques for hose clamps used in all rubber applications (radiator, air cleaner, operating lever boots, hydraulic system, etc.)

Clamp Type and Size	Torque Plus or Minus 5 lbf-in (0.6 N-m)			
	Radiator, Air Cleaner, Boots, etc.		Hydraulic System System	
	N-m	lbf-in	N-m	lbf-in
"T" Bolt (Any Diameter)	7	60	5	45
Worm Drive — 1-3/4" Open Diameter and Under	3	25	5	45
Worm Drive — Over 1-3/4" Open Diameter	5	45	5	45
Worm Drive — All "Ultra Tite"	11	100	—	—

CONVERSION TABLE

CONVERSION TABLE — INCH FRACTIONS AND DECIMALS TO MILLIMETER EQUIVALENTS

INCHES			INCHES			INCHES			INCHES		
Fract.	Dec.	mm	Fract.	Dec.	mm	Fract.	Dec.	mm	Fract.	Dec.	mm
—	.0004	.01	—	.3	7.620	—	.7874	20	—	1.969	50
—	.001	.0250	5/16	.3125	7.938	51/64	.7969	20.241	2	2.000	50.8
—	.0039	.10	—	.3150	8	13/16	.8125	20.638	2 1/8	2.125	54
—	.005	.127	21/64	.3281	8.334	—	.8268	21	—	2.165	55
—	.0079	.2	—	.3346	8.5	53/64	.8281	21.034	2 1/4	2.250	57.2
—	.0098	.25	11/32	.3438	8.731	27/32	.8438	21.431	—	2.362	60
—	.01	.254	—	.3543	9	55/64	.8594	21.828	2 3/8	2.375	60.3
—	.0118	.3	23/64	.3594	9.128	—	.8662	22	2 1/2	2.500	63.5
1/64	.0156	.397	—	.3740	9.5	7/8	.8750	22.225	—	2.559	65
—	.0157	.4	3/8	.375	9.525	57/64	.8906	22.622	2 5/8	2.625	66.7
—	.0197	.5	25/64	.3906	9.922	—	.9	22.860	2 3/4	2.750	69.9
—	.0236	.6	—	.3937	10	—	.9055	23	—	2.756	70
—	.025	.635	—	.4	10.160	29/32	.9063	23.019	2 7/8	2.875	73
—	.0276	.7	13/32	.4062	10.319	59/64	.9219	23.416	—	2.953	75
—	.0295	.75	—	.4134	10.5	15/16	.9375	23.813	3	3.000	76.2
1/32	.0313	.794	27/64	.4219	10.716	—	.9449	24	—	3.150	80
—	.0315	.8	—	.4331	11	61/64	.9531	24.209	3 1/4	3.250	82.6
—	.0354	.9	7/16	.4375	11.113	31/32	.9688	24.606	—	3.346	85
—	.0394	1	29/64	.4531	11.509	—	.9843	25	3 1/2	3.500	88.9
3/64	.0469	1.191	15/32	.4688	11.906	1	1.000	25.400	—	3.543	90
—	.0472	1.2	—	.4724	12	—	1.024	26	—	3.740	95
—	.05	1.270	31/64	.4844	12.303	1 1/16	1.062	26.988	3 3/4	3.750	95.3
—	.0551	1.4	—	.4921	12.5	—	1.063	27	—	3.937	100
—	.0591	1.5	1/2	.5	12.700	—	1.102	28	4	4.000	101.6
1/16	.0625	1.588	—	.5118	13	1 1/8	1.125	28.575	—	4.331	110
—	.0669	1.7	33/64	.5156	13.097	—	1.142	29	4 1/2	4.500	114.3
—	.075	1.905	17/32	.5326	13.494	—	1.181	30	—	4.724	120
5/64	.0781	1.984	—	.5315	13.5	1 3/16	1.188	30.16	5	5.000	127
—	.0787	2	35/64	.5469	13.891	—	1.221	31	—	5.118	130
—	.0906	2.3	—	.5512	14	1 1/4	1.250	31.75	5 1/2	5.500	139.7
3/32	.0938	2.381	9/16	.5625	14.288	—	1.260	32	—	5.512	140
—	.0984	2.5	—	.571	14.5	—	1.299	33	—	5.906	150
—	.1	2.540	37/64	.5781	14.684	1 5/16	1.312	33.34	6	6.000	152.4
—	.1024	2.6	—	.5906	15	—	1.339	34	—	6.299	160
7/64	.1093	2.776	19/32	.5938	15.081	1 3/8	1.375	34.93	6 1/2	6.500	165.1
—	.1181	3	—	.6	15.240	—	1.378	35	7	7.000	177.8
1/8	.125	3.175	39/64	.6094	15.478	—	1.417	36	—	7.087	180
—	.1378	3.5	—	.6103	15.5	1 7/16	1.438	36.51	7 1/2	7.500	190.5
9/64	.1406	3.572	5/8	.6250	15.875	—	1.457	37	—	7.874	200
5/32	.1563	3.969	—	.6299	16	—	1.496	38	8	8.000	203.2
—	.1575	4	41/64	.6406	16.272	1 1/2	1.500	38.10	8 1/2	8.500	215.9
11/64	.1719	4.366	—	.6496	16.5	—	1.535	39	—	8.661	220
—	.1772	4.5	21/32	.6563	16.669	1 9/16	1.562	39.69	9	9.000	228.6
3/16	.1875	4.763	—	.6693	17	—	1.575	40	—	9.449	240
—	.1969	5	43/64	.6719	17.066	—	1.614	41	9 1/2	9.500	241.3
—	.2	5.080	11/16	.6875	17.463	1 5/8	1.625	41.28	—	9.843	250
13/64	.2031	5.159	—	.6890	17.5	—	1.654	42	10	10.000	254
—	.2165	5.5	—	.7	17.780	1 11/16	1.688	42.86	—	10.236	260
7/32	.2188	5.556	45/64	.7031	17.859	—	1.693	43	11	11.000	279.4
15/64	.2344	5.953	—	.7087	18	—	1.732	44	—	11.024	280
—	.2362	6	23/32	.7188	18.256	1 3/4	1.750	44.45	—	11.811	300
1/4	.25	6.350	—	.7283	18.5	—	1.772	45	12	12.000	304.8
—	.2559	6.5	47/64	.7344	18.653	—	1.811	46	13	13.000	330.2
17/64	.2656	6.747	—	.7480	19	1 13/16	1.813	46.04	—	13.780	350
—	.2756	7	3/4	.75	19.050	—	1.850	47	14	14.000	355.6
9/32	.2813	7.144	49/64	.7656	19.447	1 7/8	1.875	47.63	15	15.000	381
—	.2953	7.5	—	.7677	19.5	—	1.890	48	—	15.748	400
19/64	.2969	7.541	25/32	.7813	19.844	—	1.929	49	16	16.000	406.4

SPECIAL SERVICE TOOLS REQUIRED

SECTION 1	Engine
0- 6-4	Valve guide driver
89- 10-17	Puller (for vibration dampener)
15- 13-1	Compression tester gauge (0-1000 psi)
15- 14-16	Compression tester adapter
17- 22-2	Wet sleeve puller
17- 25-13	Nozzle sleeve remover adapter
04- 33-3	Puller (for vibration dampener)
17- 52A	Engine stand
17- 52-14	Engine attaching plate
15- 67-1	Dial indicator
04- 68-3	Piston ring "drop" fixture
04-101	Camshaft bearing puller and installer set
15-115-1	Thermomelt sticks pencil (388°F)
16-148-3	Nozzle sleeve installer
04-149-3	Rear oil seal and wear sleeve installer
04-549	MT-2 Ring tool

SECTION 2	Fuel System
14- 2-78	Adapter (610 082 C1*)
14- 57-3	O-ring tool
18- 66-1	Wash tank
15- 67-1	Dial indicator
05- 70-1	Holding fixture
05- 70-5	Holding wrench
15- 71A	Nozzle tester
15- 72A	Injection nozzle adapter kit
15- 97-33	Fitting (use with Fuel Rater - 2 required)
15- 97-36	Fitting (use with Fuel Rater)
15- 97-37	Fitting (use with Fuel Rater)
05-111-2	Puller
15-3005	Diesel tachometer
15-126	Diesel field test kit
15-126-2	Thermocouple (use with test kit FES 126)
15-126-4	0-30 psi gauge (use with test kit FES 126)

*Order through Parts Distribution Center.

Refer to Agricultural Equipment Special Service Tools and Equipment Manual PSB-11, for prices and ordering procedure.

SECTION 2**Fuel System - Continued**

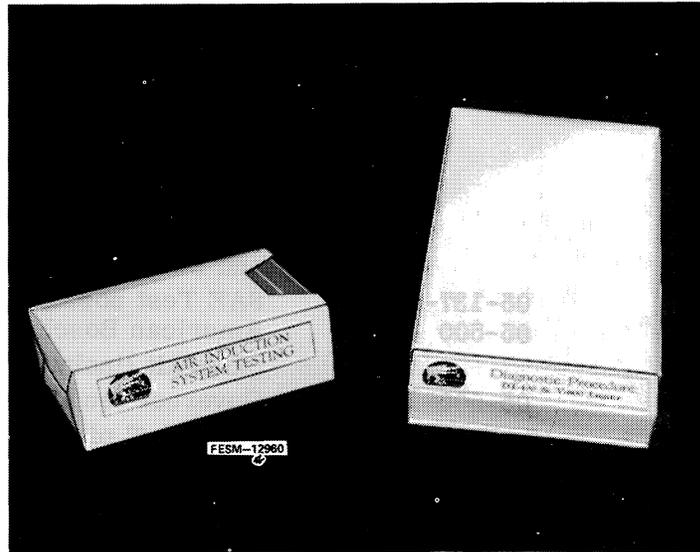
15-136	Fuel Rater Model U-7500A Test stand (Bacharach no. 67-8026) w/built in pressure lube oil unit Accessory set for testing Model 100 pump on FES 137-5 test stand (Bacharach no. 67-8123) Accessories for testing Model 100 pump on Model U-7000 and U-7500 test stands (Bacharach no. 67-3969) Pressure lubricating oil supply unit required for testing Model 100 pumps on Model U-7000 and U-7500 test stands (Bacharach no. 67-7227)
05-137-20	SAE Test nozzles (.05 MM)
05-500	American Bosch Model 100 series injection pump kit (includes the following)
05-500-1	Governor tension spring removing and installing tool (2 pieces)
05-500-2	Drip tube assembly
05-500-3	Plunger lift measuring tool
05-500-4	Holding fixture with funnel and tube
05-500-5	Torque cam angle and protractor
05-500-6	Governor spring adjusting gauge
05-500-7	Delivery valve checking fixture
05-500-8	Plunger spring compressor tool
05-500-9	Governor drive gear nut spanner socket
05-500-10	Holding bar
05-500-11	Support bar
05-500-12	Support block
05-500-13	Arkansas stone

SECTION 3**Turbocharger**

14- 57-3	O-ring tool
15- 67-1	Dial indicator
15-126	Diesel field test kit
15-126-2	Thermocouple (for use with test kit FES 126)

Refer to Agricultural Equipment Special Service Tools and Equipment Manual PSB-11, for prices and ordering procedure.

Service Information System (S.I.S.)



S.I.S. is an in-dealership, on-the-job service training system. It makes use of a film viewer to allow the learning serviceman to watch and listen to a short series of instructions and then perform that procedure on your customer's equipment.

A typical program cartridge contains approximately 100 color pictures. Programs are available in the Fairchild format as shown above with the Fairchild 410 viewer. The filmstrip is synchronized for complete stop, start and rewind capabilities. Programs are also available in LaBelle format for dealers in the Truck Group's Super Com program. See next page for a complete listing of S.I.S. training programs available.

The following S.I.S. programs are available to be used in conjunction with this Service Manual:

- 400 and V-800 Engine Diagnostic Procedures
- 400 Series Engine Overhaul
- Air Induction System Testing
- AMBAC Injection Pumps
- Diesel Engine Failure Analysis
- Cooling System Operation & Maintenance
 - 300 & 400 Series Engines

The following programs are available. You can order them on a GF-91 order form through the General Marketing Office. Contact your District Office Service Manager for full details.

Service

Louisville Tractors (74 Series)

- Brake Overhaul
- Hydraulic System Testing

84 Series Tractors

- Pre-Delivery
- Electrical System
- Hydrostatic Pre-Delivery, Testing & Overhaul
- Brake Overhaul

86 Series Tractors (Except 4386, 4586 & 4786)

- Pre-Delivery Service Part 1 & 2
- Delivery Service Part 1 & 2
- After Delivery Service
- Rear Split-Cab on Rear Part 1 & 2
- TA Overhaul Part 1 & 2
- Brake Overhaul (Except 1586)
- Rear Split-Cab on Front Part 1 & 2
- IPTO Overhaul
- Final Drive Overhaul (Except 1586) Part 1 & 2
- MCV Overhaul and Testing
- Data Centers, Testing & Troubleshooting
- Air Conditioning
- Clutch Adjustment & Overhaul
- 186 Hydro – Testing & Troubleshooting

4386 & 4586 Tractors

- Pre-Delivery Service

3388, 3588 & 3788 Tractors

- Principles of Operation PFC Hydraulic System
- Pre-Delivery Service
- PFC Hydraulic System Testing Procedure
- Data Centers, Testing & Troubleshooting
- Clutch Adjustment & Overhaul
- Hitch Pump Replacement & Hitch Adjustments

5088, 5288 & 5488 Tractors

- Pre-Delivery Service
- Delivery Service

Engine & Fuel System

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GENERAL SHOP PRACTICES FOR ENGINE OVERHAUL

Diesel Engines

Engine Overhaul Procedures

Engine rebuild failures can occur because of poor shop practices. The information provided under the section of "General Shop Practices for Engine Overhaul" is not to supersede, nor is it intended to be all inclusive of all information available to service personnel through other International Harvester Publications as well as this service manual. The intention of this section is to present common procedures viewed in the field and to present sound shop practices recommended for engine overhauls.

Sources of Debris in Engines

Some types of failures may result in contamination (that is metal debris) being distributed throughout the entire engine to varying degrees. Service personnel should note that such debris may be accumulated in the oil pump assembly, oil filter base housing, injection pump, oil cooler, oil pressure relief valve and/or oil supply galleys in the head and block.

The degree of the failure, the size, volume, type and location of the contaminant are all factors that determine the extent of cleaning necessary. All reusable engine parts are considered cleanable, except under certain circumstances, such as the oil cooler. The oil cooler should be replaced when a large collection of metal contaminants are found in the oil pan and/or lube system, which could have blocked or restricted its passages. However, the oil cooler may be successfully cleaned of light suspended contaminants such as antifreeze by flushing in a good cleaning solvent such as Union Carbide's Butyl Cellosolve.

When failures such as piston scoring, rod failures, or (dusting) failure from an air induction leak occurs, it is recommended that the crankcase and cylinder head be steam cleaned or boiled out in a hot tank. Failure to do so often results in very short rebuild life.

Properly Assemble and Test the Air Induction System

Proper assembly and servicing of the air induction system is of vital importance in preventing a dusted engine and in obtaining optimum performance testing.

Air Induction System Testing

The introduction of dirt through the air induction system will cause excessive wear of the rings and cylinder sleeves and premature engine failure. The air induction system, composed of an air cleaner assembly, intake pipe, hoses and clamps, must be completely sealed to prevent unfiltered air from entering the engine. The air cleaner must be the only source of air to the engine.

An improved air induction hose clamp is now available for use on all machines. The new clamp is torqued at 11.2 to 13.8 N·m (100 to 125 in. lbs.) resulting in a better seal at the hose connections.

To insure that all air passages through the air cleaner, the air cleaner element seals and gaskets must always be in excellent condition. Hold down nuts should never be overtightened. Overtightening will cause distortion of the main element housing and filter element housing, allowing air to bypass the filter assembly.

Visually inspect element seals and canister sealing area for signs of the seal sticking. If sticking is evident, replace the element and remove all seal material from the canister. If seal material is not removed, the new filter element may not seal properly.

Check the element for damage caused by improper handling or storage. Never tap an element on a hard surface or use more than 690 kPa (100 psi) of air pressure to clean a filter element. Improper cleaning procedures can damage the element and allow the engine to be damaged in a few hours.

In addition to the air cleaner element, the remainder of the air induction system must be properly maintained. This can best be checked by pressurizing the air induction system. The procedure is applicable to both turbocharged and naturally aspirated engines. A naturally aspirated engine will operate under negative manifold pressure at all times. A turbocharged unit will operate with a negative pressure from the air filter to the turbocharger and a positive pressure from the turbocharger to the engine. If leaks between the turbocharger and engine are present, poor performance may be encountered.

The tools and materials required to pressurize the air induction system include a roll of duct tape, paint brush, liquid soap, one-quarter inch air hose with push lock male pipe fittings and quick disconnect fittings, pressure regulated air source and 0-100 kPa (0-15 psi) pressure gauge.

The safety element should be taped completely so no air can escape through the filter assembly. The tape must overlap so there are no gaps where air leakage can occur. Install the taped element.

Remove the air cleaner indicator line or intake manifold plug and install the 0-100 kPa (0-15 psi) pressure gauge. This gauge will indicate actual air pressure in the air induction system during the test procedure. Attach a regulated air source to the intake manifold pressure test port. Pressurize the intake system to 20 kPa (3 psi).

In a container, mix the liquid soap with water. Use the paint brush to systematically soap all air induction system connections. Include hoses, metal pipe, ether can holder, ether and air restriction sending unit connections and the turbocharger. If a leak is found, it should be corrected immediately.

If an engine failure indicates the ingestion of dirt into the engine, the air induction system should be tested as explained. This procedure should also be performed any time the air induction system is suspect to insure the customer maximum service.

The above procedure is also covered in an SIS film, "AIR INDUCTION SYSTEM TESTING".

Cleaning Pistons and Sleeves

As received in shipping packages from PDC's, pistons and sleeves require cleaning prior to installation into crankcases. It is essential that all contamination be removed from surfaces of pistons and sleeves. The wiping of a sleeve and/or piston with a treated pad and/or an oil soaked rag is not sufficient to clean out the minute metal particles.

It is recommended that parts as received, as well as those reinstalled, should be washed in a hot liquid detergent and water solution, rinsed and dried, then coated with a thin film of clean 30 weight

engine oil to prevent rust. Detergent acts to "lift up" the metal particles. Using hot water or a steam gun will provide adequate heat for the sleeve and/or piston to evaporate the water off. Wipe repeatedly with light engine oil and clean rags until a clean white rag shows no evidence of discoloration from the piston and/or sleeve.

Pistons and Sleeves

Pistons and sleeves furnished for diesel engines are not matched. New diesel engine pistons and sleeves may be intermixed. Pistons and sleeves being reused must be kept in sets and reinstalled in the same bore from which they were removed. This is also true when only piston rings and/or O-rings/seals are replaced.

Skirt clearance can be obtained by first measuring the piston 90 degrees from the pin hole near the bottom of the skirt. The I.D. of the sleeve should then be measured in the middle area of sleeve. By comparing sleeve I.D. to piston O.D., the skirt clearance can be determined. Piston and sleeve clearance can be measured most accurately using micrometers. Refer to the appropriate service manuals for skirt clearance specifications.

Knurling of pistons is not an approved practice. Knurling of the piston deforms the O.D. of the piston. This may cause heavy piston to sleeve contact, resulting in scoring.

Installation of Sleeves

Sleeve O-rings should be coated with clean engine oil and when applied, any excess will easily run off. Excessive application of a more solid lubricant may cause marginal deformation of the sleeve diameter.

Installing Pistons and Sleeves

Sleeves must be installed in the crankcase and clearances checked, using only the piston to be installed on that sleeve. Prior to installation of the sleeve, clean the crankcase bore. If not properly cleaned, the sleeve will be distorted, causing damage to piston and rings. Pistons and (wet) sleeves can be measured in their free state, at room temperature, using micrometers.

Rotate Wet Sleeves

When wet sleeves are reinstalled in diesel engines, service personnel may elect to rotate the sleeve 90° from its original position if signs of cavitation exist. This provides a new surface to resist the effects of cavitation and erosion, lengthening the useful life of the sleeve.

Ribbon Fitting

Ribbon fitting of pistons and sleeves is no longer recommended.

Honing/Deglazing

New IH cylinder sleeves do not require honing or deglazing prior to installation.

All Neuss engines, 300 & 400 series engines and the V-800 engines, use sleeves that are plateau honed and should never be honed or deglazed. Service equipment used in the field cannot produce the plateau honed surface required to provide extended ring life.

A common term used today when examining cylinders and sleeves is that the ring travel area is "glazed". The definition of "glazed" can vary widely from one observer to another.

The following is offered as the correct definition:

A sleeve that no longer has evidence of a cross hatch pattern, whether isolated to certain areas of the ring travel or in the entire ring travel area, is simply "worn".

A sleeve that appears shiny or has what appears to be a brown or yellow varnish in the ring travel area is "glazed". Glazing occurs when fuel and oil deposits and combustion soot accumulate on the wear surface of the cylinder walls. If a sleeve is reinstalled without removal of the glaze or varnish, it is possible the engine may consume excessive amounts of oil as the piston rings may not make proper sealing contact with the cylinder walls.

It should be noted that the glaze which can accumulate on diesel cylinders and sleeves can be removed using a 50/50 mix of hot water and liquid detergent.

Cleaning the Cylinder Head

Failure to clean valve guides prior to reassembly can cause premature valve guide wear, high engine oil consumption, and in extreme conditions valve breakage. All guides furnished as service parts are reamed to size. Since they are a press fit in the head, it is necessary to ream them again to remove any possible burrs or slight distortion caused by the installation.

Valve guides installed in used cylinder heads and new service cylinder heads must be cleaned as outlined below.

1. Coat a nylon brush (which has a slightly larger diameter than the I. D. of the valve guide) with soap and hot water.
2. Insert the brush into the I. D. of valve guide, and with a turning motion, run the brush through to insure removal of gum, carbon deposits and rust preventative from the guide and spiral grooves.
3. Rinse with hot water, dry thoroughly.
4. Thoroughly coat the guide with clean engine oil after the cleaning operation is complete

IMPORTANT: When installing the valves and retainers, do not use grease. Grease may stop the flow of oil into the valve guide and cause valve guide wear.

Keep Engine Components Clean at All Times

Prior to and during installation of engine components, assemblies must be covered and not exposed to contamination. Failure to provide clean parts will result in premature internal engine wear and/or high oil consumption.

SEALING COMPOUND USE

LOCTITE RETAINING AND SEALING COMPOUNDS

Compound Description

These products are single component, self-curing, polyester compounds which remain liquid while exposed to air, and harden by chemical action into tough structural solids when confined between closely mated metal parts. These compounds will resist solvents, heat, shock and vibration and are intended to provide a positive seal against leakage, and shear strength resistance to loosening when used in the assembly of threaded, slip fit, or press fitted parts.

Loctite Grades (General Usage)

1. GRADE B (YELLOW) — Straight threaded fasteners.
2. GRADE “AVV” (RED) — Straight threaded fasteners; higher strength for studs, etc.
3. PLASTIC GASKET (RED) — Use as seal between mating surfaces (face sealant).
4. HVV (UNFILLED PIPE SEALANT) — Use on tapered pipe threads.
5. HYDRAULIC SEALANT — Use on fuel fittings with straight pipe threads.

NOTE: Once cured, these compounds have an operating temperature range of -55°C to 150°C (-65 to 300°F) and will resist attack by oils, chemicals, hydraulic fluids and solvents.

Exceptions DO NOT use Loctite:

1. Where other means of retaining the assembly are provided such as, prevailing torque fasteners (fasteners with distorted threads or plastic inserts), lock washers, lock plates and lock wires.
2. On items requiring frequent servicing.

3. When the operating temperature exceeds 150°C (300°F). (Example: Engine Exhaust Systems).

4. On brass fittings and plugs.

SURFACE PREPARATION

Plain and Phosphate Coated Parts

Clean the surfaces where compounds are to be applied to remove heavy coatings of oil grease and dirt (rust or light oil film are not detrimental). Normal shop practice of cleaning or degreasing is adequate. Phosphate and oiled hardware is used in the “as received” condition.

Zinc or Cadmium Plated Parts or for Rapid Hardening

At least one of the mating surfaces should be degreased with a cleaning solution to which concentrated primer has been added. (1 part primer concentrate to 30 parts trichlorethylene or 1-1-1 trichlorethylene). Allow surfaces to dry for 3 to 6 minutes before applying compound.

Drawbar Studs or Special Stud Applications

Degrease parts with a cleaning solution to which concentrated primer has been added. (1 part primer concentrate to 30 parts trichlorethylene or 1-1-1 trichlorethylene). Allow surfaces to dry for 3 to 6 minutes before applying compound. In blind holes be sure to remove all chips and oil.

Face Sealant (Plastic Gasket)

Mating parts must be cleaned as for plain and phosphate coated parts.

APPLICATION

Cap Screws and Pipe Threads

Fill the first 2 to 3 leading threads in area of engagement with compound. For large quantities of cap screws, may also be applied by tumbling method (refer to manufacturer's instructions).

Studs

Apply by hand to individual studs. Fill full length of thread with one strip on diameters up to 25 mm (1 inch), two strips 180° apart on diameters up to 50 mm (2 inches), and three strips 120° apart on diameters over 50 mm (2 inches). In all cases apply one strip into tapped holes.

Blind hole applications — apply enough compound to fill the bottom 2 to 3 threads of engagement, then insert stud. If engagement length exceeds one diameter use proportionally more compound.

For non-seated studs (studs that can go deeper in hole than required) turn stud one turn deeper than required. After bubbling stops, apply a ring of compound around stud at top of hole, then turn back to required height.

Face Sealant (Plastic Gasket)

Spread an even coat 1 cc per 260 cm² (40 sq. inches) on one of the mating surfaces. Assemble and tighten bolts.

NOTE: On crawler tractor applications only, when compound is used as a gasket, bolts which attach the parts should be coated with MPL (gear lubricant) to prevent compound from sticking to bolts.

APPLICATION AT LOW TEMPERATURES

1. Without special precautions, these compounds can be applied and will cure at temperatures down to 10°C (50°F), and at that temperature full strength will be obtained within 72 hours.

2. At temperatures from 10° to -18°C (50° to 0°F), the use of primer is recommended.

3. If necessary, the compounds can be applied at temperatures below -18°C (0°F), only if heat is used to accelerate the cure as follows:

65°C (150°F) for 60 minutes
93°C (200°F) for 45 minutes
120°C (250°F) for 30 minutes

SETTING TIME (BEFORE PLACING IN OPERATION)

1. Normal time for compound grades without use of any primer — 6 to 24 hours at room temperature with machined carbon steel parts. Higher temperatures will accelerate cure and lower temperatures will retard cure. Other base metals will provide more or less catalytic effect on cure.

2. Primed surfaces — 2 to 6 hours. This may be speeded by pretreating mating surfaces with special primers. Some metals (such as zinc and cadmium plate, anodized aluminum, and passivated stainless steel) are inactive and require heat or primer to cure the compound.

3. A fast curing type primer will fix parts for normal handling in 10 to 15 minutes and will achieve 75 percent of ultimate strength in 1 hour and full cure in 2 to 4 hours.

REMOVAL

Parts difficult to remove can be preheated to 205° to 260°C (400° to 500°F) prior to removal.

Section 1

ENGINE Contents

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SPECIAL NUT AND BOLT TORQUE DATA (In Foot Pounds)

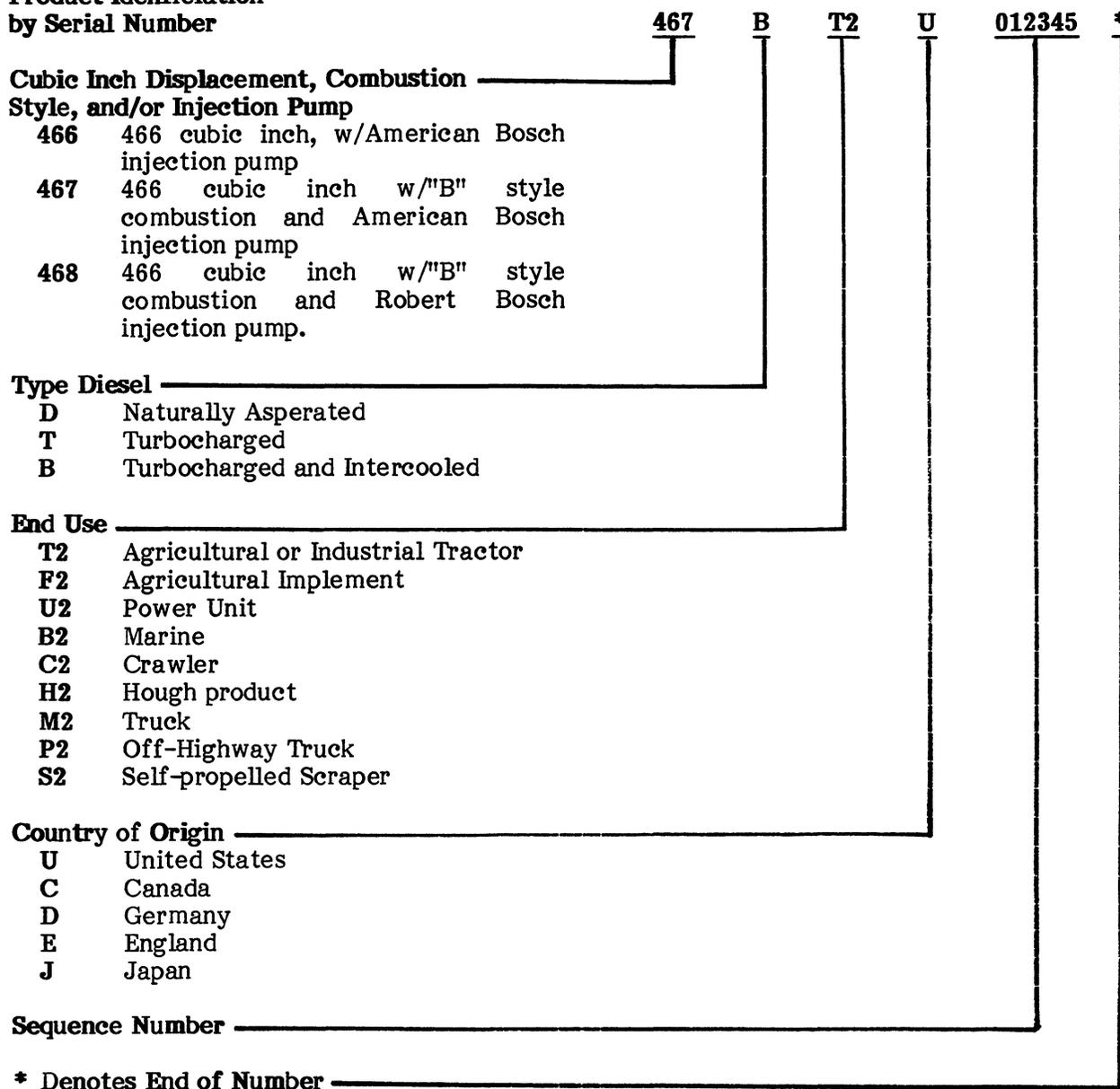
Alternator pulley nut	
w/.87 Inch dia. shaft	102 N·m (75 ft. lbs.)
w/.67 Inch dia. shaft	68 N·m (50 ft. lbs.)
Breather housing nuts - (414, 436, 466 Series)	16 N·m (12 ft. lbs.)
Camshaft thrust plate bolt	27 N·m (20 ft. lbs.)
Connecting rod bolts	176 N·m (130 ft. lbs.)
Crankcase front plate bolt	27 N·m (20 ft. lbs.)
Cranking motor mounting bolts	115 N·m (85 ft. lbs.)
Crankshaft main bearing cap bolt	156 N·m (115 ft. lbs.)
Crankshaft pulley retainer bolts	170 N·m (125 ft. lbs.)
*Cylinder head bolts	225 N·m (165 ft. lbs.)
Cylinder head valve cover bolt	2.8 N·m (25 in. lbs.)
Exhaust manifold nuts	77 N·m (57 ft. lbs.)
Exhaust outlet elbow to cylinder head bolt	
(414, 436, 466 Series)	230 N·m (170 ft. lbs.)
Flywheel bolts	149 N·m (110 ft. lbs.)
Flywheel housing mounting bolts	142 N·m (105 ft. lbs.)
Idler gear carrier bolt	115 N·m (85 ft. lbs.)
Injection nozzle holder retaining bolt	27 N·m (20 ft. lbs.)
Injection pump drive gear bolts	41 N·m (30 ft. lbs.)
Intake manifold bolt	27 N·m (20 ft. lbs.)
Intercooler mounting bolts	20 N·m (15 ft. lbs.)
Oil filter by-pass valve cap	68 N·m (50 ft. lbs.)
Oil pan drain plug	45 N·m (33 ft. lbs.)
Oil pan bolts	27 N·m (20 ft. lbs.)
Oil pressure regulating valve cap nut	230 N·m (170 ft. lbs.)
Turbocharger air hose clamps	5 N·m (45 in. lbs.)
Turbocharger mounting bolts	47 N·m (35 ft. lbs.)
Tachometer drive thrust plate nuts	27 N·m (20 ft. lbs.)

*To be torqued in sequence and steps as shown on the cylinder head torque pattern chart in "Installation" of cylinder head.

NOTE: All engine bolts are type 8. However, except for special torques, they are to be torqued to type 5 specifications.

INTRODUCTION

**Product Identification
by Serial Number**

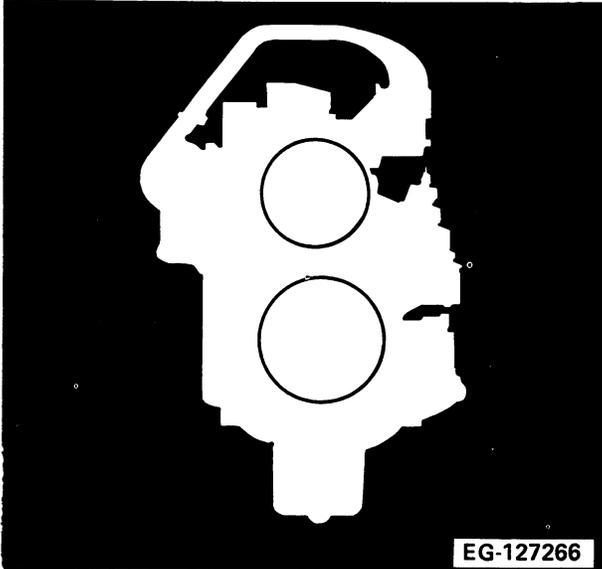


The engine serial number **467BT2U012345*** denotes an engine of 466 cubic inch displacement w/"B" style combustion, American Bosch injection pump, turbocharged and intercooled Diesel, for Agricultural or Industrial tractor, manufactured in the United States and identified as twelve thousand three hundred and forty five for production and record purposes.

INTRODUCTION

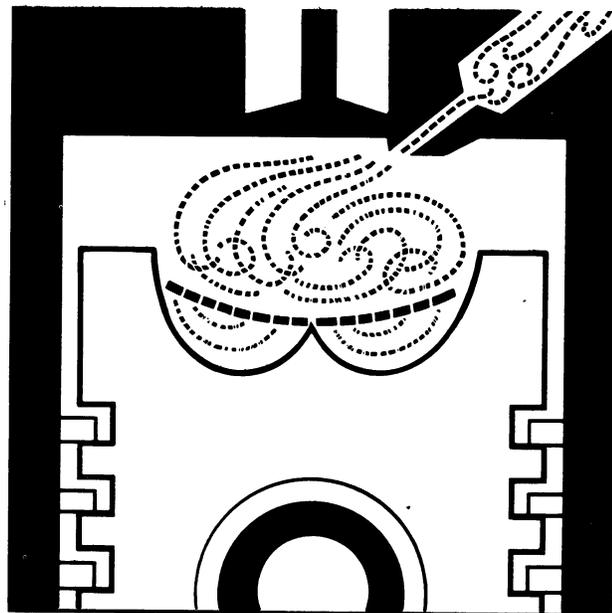
ENGINE FEATURES

DESCRIPTION



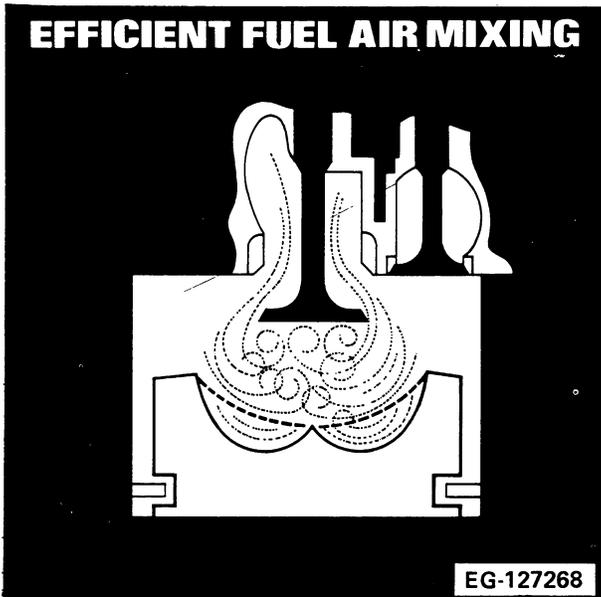
The 300/400 Series comprise a line of premium quality mid-range engines used in various Agricultural Equipment, Construction Equipment, On-Highway Truck and OEM applications.

All are direct starting, valve-in-head type with direct fuel injection.



EG-127267

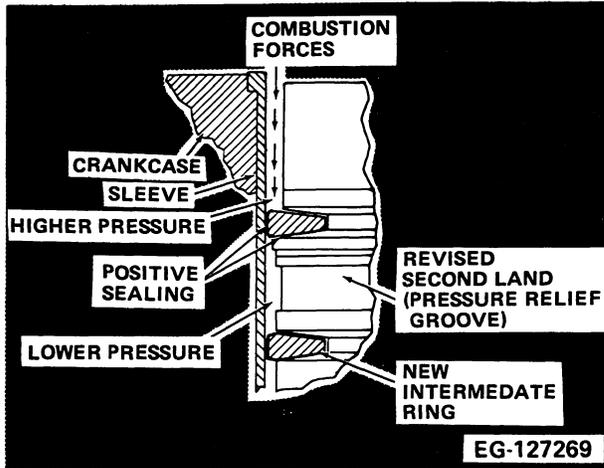
EFFICIENT FUEL AIR MIXING



EG-127268

The cylinder head design initiates a swirling motion to the air entering the cylinders from the intake manifold to create high turbulence air-to-fuel mixing, resulting in greater efficiency.

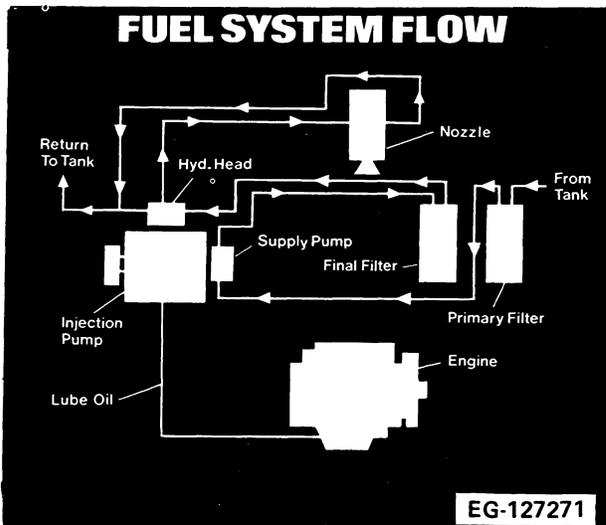
INTRODUCTION



For ease of service all 300/400 series engines are equipped with two spin-on, throw-away type oil filters.

DESCRIPTION

The Turbocharged 400 Series Engines incorporate a "BALANCE PRESSURE" PISTON with a revised second land configuration and top ring groove and a new INTERMEDIATE PISTON RING. These technological advances provide a more positive seal for the top ring against the bottom of the top ring groove and cylinder wall (sleeve). Engine oil control is improved significantly.

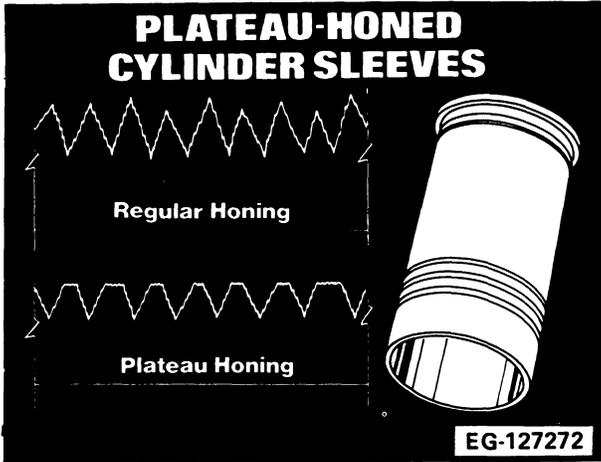


A fuel system which accurately meters the required amount of fuel for complete combustion, and provides complete governor control for power take off applications without the additional cost of add-on governors.

Incorporated in a built-in timing advance and excess fuel control device which allows smooth, quiet, and unaided starting down to 20°F. or below.

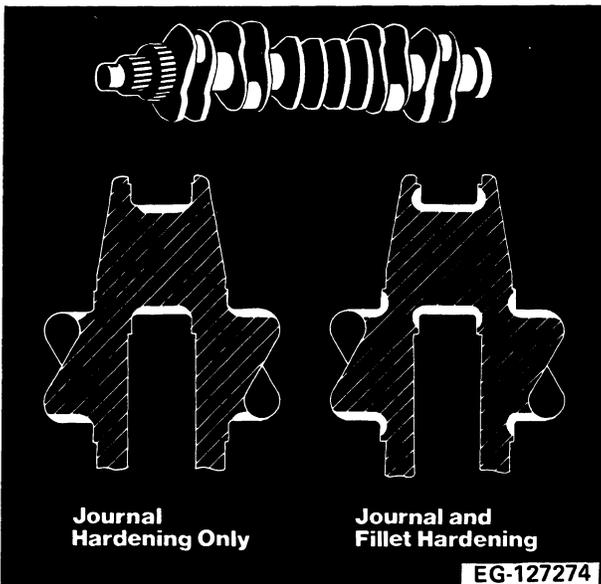
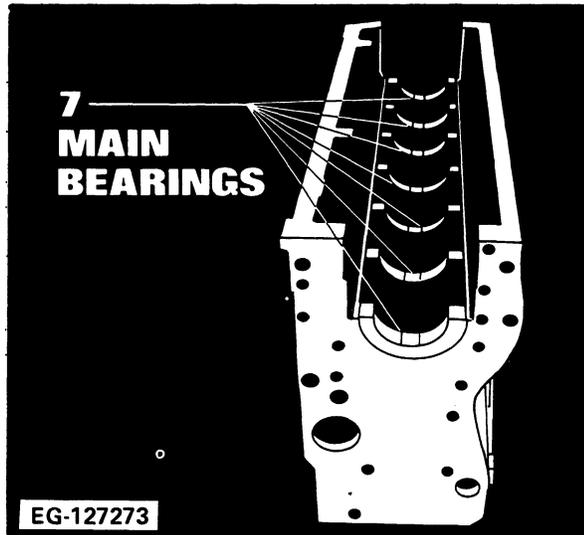
INTRODUCTION

DESCRIPTION



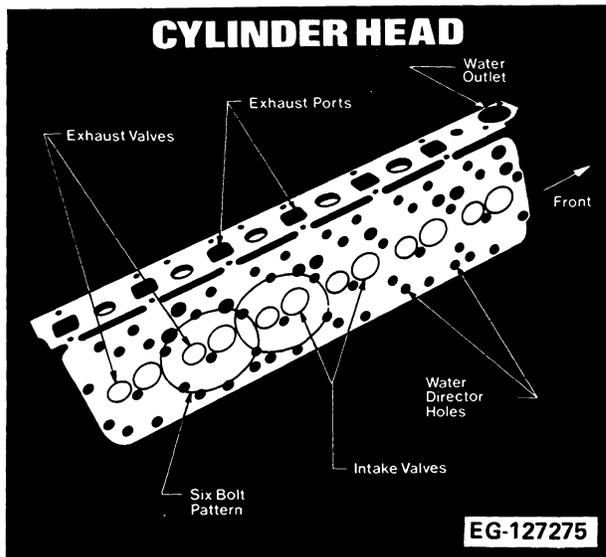
Cylinder sleeves are of the replaceable, wet-type which are surrounded by water to provide immediate positive heat dissipation. The sleeves are machined by a special process called Plateau-Honing. This process provides a sleeve finish which results in rapid engine run-in. Induction hardening of the sleeves I.D. results in low wear rates and long life. (Hardening is used only on certain applications with higher HP ratings).

The block is made of high strength alloy iron which minimizes weight without sacrificing engine rigidity. An outstanding feature of the 400 series engines is that crankshaft wear is distributed over 7 main bearings.



The crankshaft is constructed of induction hardened forged steel; International not only induction hardens the journal areas, but the fillet areas as well on 466 Series Engines,

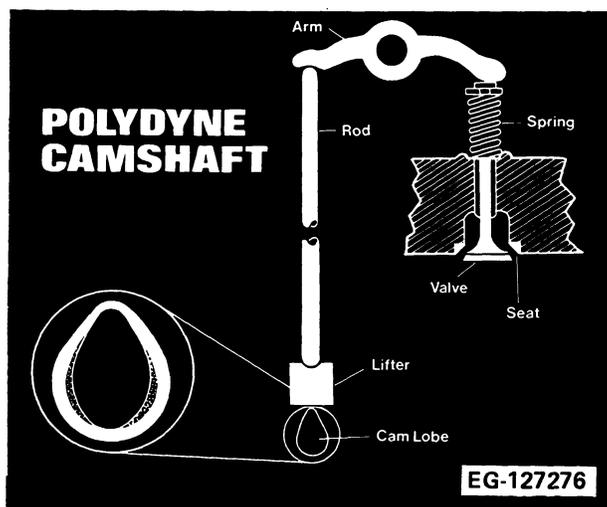
INTRODUCTION



DESCRIPTION

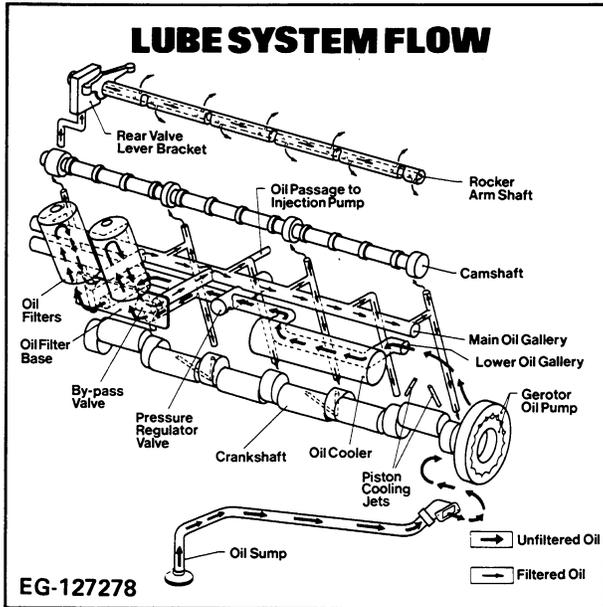
The cylinder head is a one piece, iron alloy casting with a six bolt pattern around each cylinder which assures positive head gasket sealing.

The camshaft is a steel forging with induction hardened lobes. It is a "Polydyne" design camshaft which means that valve travel speed is reduced just before valve seating to allow gentle seating of valves. As a result of this "Polydyne" design camshaft, superior valve life can be achieved.



The lubrication system in the Turbocharged 400 series engines addresses the problem of on-the-spot immediate cooling with twelve oil cooling jets installed in the main bearing webs, two per cylinder. These cooling jets facilitate piston and wrist pin cooling, thus eliminating the possibility of heat build-up in these hard-working high friction areas.

INTRODUCTION



DESCRIPTION

A unique feature of this lubrication system is the pressure regulating valve. It not only controls the pressure and flow of clean oil released from the oil filters going to the main oil gallery and other critical areas of the engine, but this oil regulator controls the flow of unfiltered oil entering the filters. Excess unfiltered oil is dumped back into the oil pan before it can reach the filters. This added control eliminates the possibility of overloading the filters by dumping oil before filtering, thus adding to oil filter life.

ENGINE START-UP

1. Run at low idle and check rocker arm lubrication — reinstall valve cover.
2. Inspect visually for coolant and oil leaks.
3. Start engine run-in (**See NOTE**).

NOTE: Follow specified engine run-in procedures. Failure to do so will result in engine failure such as piston/sleeve scoring and/or excessive oil consumption.

4. Retorque cylinder heads at specified time period during run-in. Failure to do so will result in head gasket failure.
5. Complete engine run-in.
6. Obtain In-Chassis Engine Performance Data.
7. Retorque all external fasteners (Nuts, bolts and hose lamps).
8. Engine can now be placed back into service.

NOTE: Follow-up should be made per after delivery service for specific application. This follow-up service must be made on engine if complete engine disassembly was necessary.

PROBLEM AND ANALYSIS GUIDE

PROBLEM – OIL CONSUMPTION

DISCUSSION

Before any corrective action is taken on a high oil consumption complaint, be sure to determine whether or not a problem exists*. An engine working under average field conditions uses some oil. Listed below are maximum acceptable limits for oil consumption grouped in horsepower range:

*See discussion on **SLOBBER** below.

P.T.O. Horsepower	Oil Consumption Limit Per 10 Hours
50 to 100 HP	1.0 qt.
100 to 260 HP	2.5 qts.
260 to 300 HP	3.3 qts.
300 to 550 HP	5.0 qts.

I. **CHECKING FOR OIL CONSUMPTION:** To obtain accurate oil consumption rate the oil level should be checked with the engine warmed up to operating temperature and the machine parked in a level position. The dipstick seal must be loose and the gauge inserted and removed slowly in order to obtain an accurate and repeatable oil level check. The following procedure is recommended:

1. Change the engine oil and engine oil filter. Fill to 1/2 inch below the "full" mark on the dipstick (this allows for hot oil expansion). Use IH Engine Oil of SAE 30 Viscosity or an oil which meets IH specifications.
2. Operate the machine in the field or on a dynamometer for one hour under normal load conditions to reach normal oil expansion.
3. Stop the engine, with the machine on level surface. After the engine has been shut down for 15 to 20 minutes, check the engine oil level and add oil to bring it up to the "full" mark. This will be the start of the oil consumption test and an accurate record of operating time must be kept from this point until the test is terminated.

4. Run the machine in the field for about 5 hours. Shut the engine down for 15 to 20 minutes and check the oil level; again with the machine level. Add oil as needed (in full quart increments) to bring the level up near the "full" mark, not above it.
5. Continue operating for the rest of the day and then recheck the oil level, with the machine level, after the engine has been stopped for 15 to 20 minutes.
6. Add oil to the engine to bring the level up to the "full" mark or the same as at the beginning of the test in step 3. Total up the operating hours and all oil added in steps 4 and 6. Calculate the oil consumption by taking the total amount of oil used and dividing it by the number of hours run to determine oil consumption per hour. Multiply that figure times 10 and you will have oil consumption per ten hours.

Example:

1.25 qts. used in 9 hours

$$\frac{1.25}{9} = .139 \text{ per hour}$$

$$.139 \times 10 \text{ hours} = 1.39 \text{ per 10 hours}$$

Care must be taken in measuring for oil consumption to obtain accurate test results.

II. **CAUSES FOR EXHAUST "SLOBBER" ON DIESEL ENGINES:** It is fairly common for a black liquid substance to run out of the exhaust manifold on diesel engines. This substance is usually thin enough to leak from any joint that is not sealed with a gasket. Some observers have mistakenly concluded that the "slobber" is engine lubricating oil and that something is wrong with the engine. They may relate this to oil consumption even when the consumption is within acceptable limits.