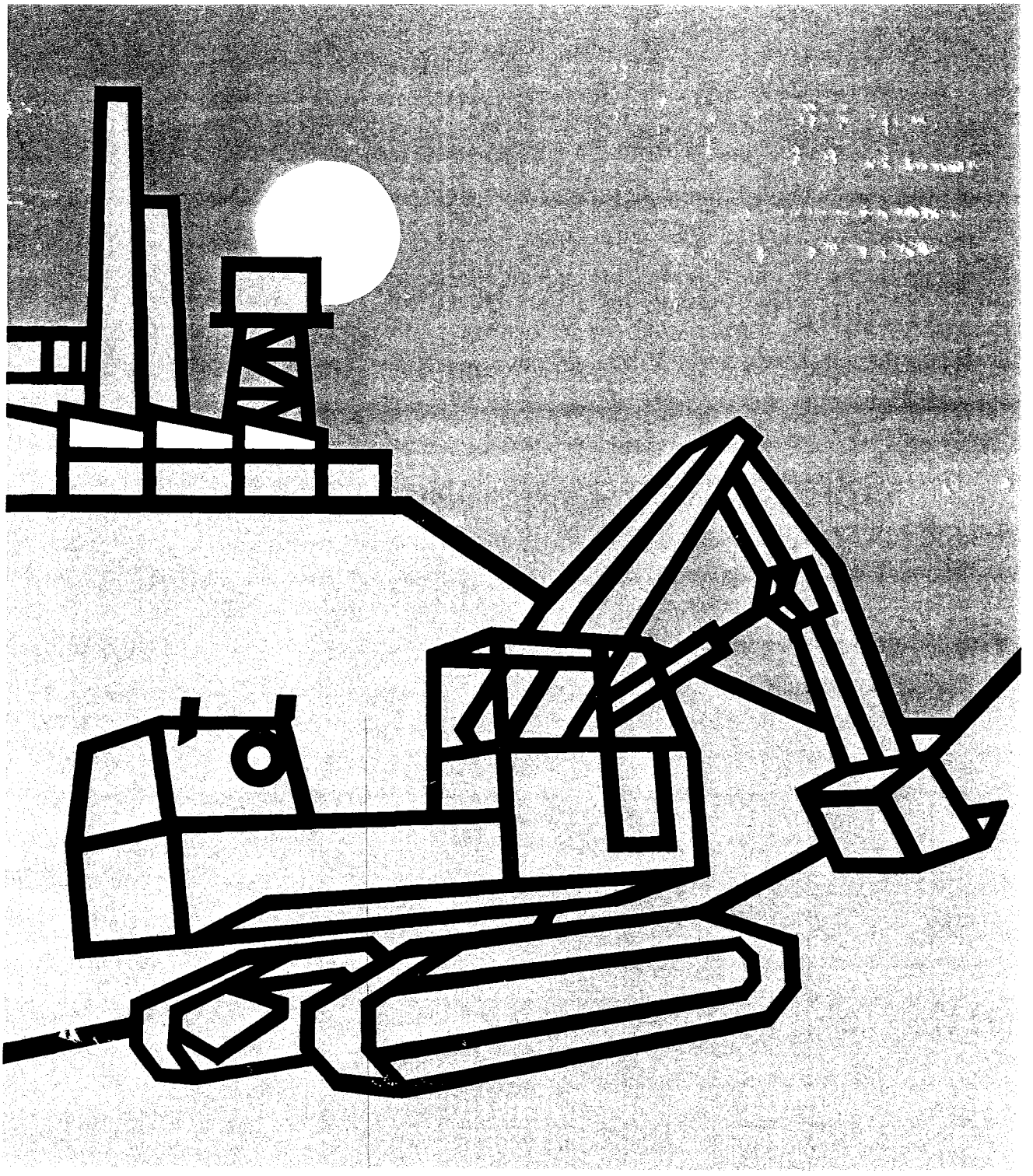
Construction/Industrial Diesel Engines
Operation and Maintenance Manual



Operation and Maintenance Manual

Cummins Diesel Engines

Agricultural

Construction

Industrial

Industrial Fire Pump

Logging

Mining

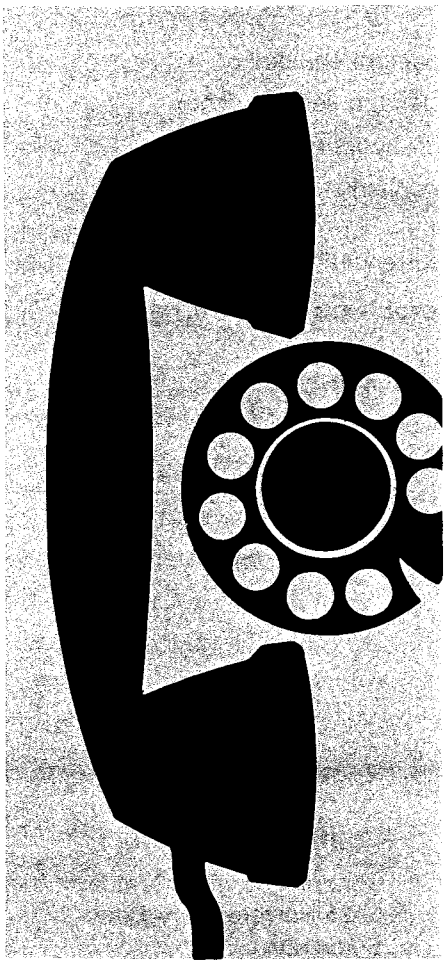
Railway

Generator

Bulletin 3379052-07, Printed 11/78

Emergency Service Assistance

If you should require emergency service assistance, check the yellow pages for the nearest Cummins distributor or authorized dealer.



Should you be unable to reach the local dealer or distributor in the above manner, Cummins Engine Company has established a 24 hours a day, toll free number for service assistance. In 47 states, you can call Cummins Customer Relations toll free by dialing 800-457-5300. In Alaska, Hawaii, Indiana and Canada, call collect 812-379-6115.

Cummins Owner Assistance

Cummins Engine Company backs its engines with expert service and complete parts support. We built a service network of more than 3,000 Cummins distributors and dealers, the largest in the world devoted exclusively to diesel engines. We trained our people to provide the Cummins owner with sound advice, expert service and professional treatment at all Cummins locations.

Any problem that you have in connection with the sale, operation or service of your engine can be handled at the nearest Cummins location. Occasionally, you may feel a problem has not been handled to your satisfaction. At those times, we urge you to pursue the problem until you are satisfied.

Many problems result from a breakdown in communications and can often be solved by bringing in a third party as a mediator. Bring your problem to the next higher authority to discuss.

We recommend:

1. If problem originates with a salesperson or service technician, talk to the sales or service manager.
2. If problem originates with a sales or service manager, talk to the owner of the service location.
3. If problem originates with a dealer, talk to the Cummins distributor with whom he has his service agreement.
4. If problem originates with a distributor, please call the nearest Cummins Divisional Office. Most problems are solved at or below the divisional office level. Their phone numbers and addresses are listed below. However, before you call, write down the following information and have it ready:
   A. Name and location of the Cummins distributor or dealer
   B. Type and make of equipment
   C. Engine model and serial number
   D. Total miles or hours of operation
   E. Nature of problem
   F. Summary of the current problem arranged in the order of occurrence.

If you still have problems please write:

Customer Relations
Cummins Engine Company, Inc.
1000 Fifth Street
Columbus, Indiana 47201

We do request that the above steps be followed in order. Most of the actual work on an engine can be performed at the original location, so please give them a chance to satisfy you first.

Cummins Divisional Offices

Canadian Division

Cummins Engine Company, Inc.
77 City Centre Drive
Suite 302
Mississauga, Ontario
Canada
Phone: 416-270-0240

Eastern Division

Cummins Engine Company, Inc.
Norwalk Towers
Suite 200
Bedlon Avenue & Cross Street
Norwalk, Connecticut 06850
Phone: 203-846-3241

Midwestern Division

Cummins Engine Company, Inc.
Oak Brook East Building
2000 Spring Road
Oak Brook, Illinois 60521
Phone: 312-654-0020

Plains Division

Cummins Engine Company, Inc.
Twin Towers, North
Suite 633
8585 North Stemmons Freeway
Dallas, Texas 75247
Phone: 214-638-5410

Rocky Mountain Division

Cummins Engine Company, Inc.
5660 S. Syracuse Circle
Englewood, Colorado 80110
Phone: 303-773-2866

Southern Division

Cummins Engine Company, Inc.
6425 Powers Ferry Road
Suite 120
Atlanta, Georgia 30339
Phone: 404-955-5025

Western Division

Cummins Engine Company, Inc.
Two Embarcadero Center
Suite 2050
San Francisco, California 94111
Phone: 415-981-2900

Foreword

This is an engine operation and maintenance manual, not a repair manual. The design of Cummins Engines makes it possible to replace worn or damaged parts with new or rebuilt parts with a minimum of down time. Contact the nearest Cummins Distributor for parts replacement as they are equipped and have well informed, trained personnel to perform this service. If your shop is properly equipped to perform either maintenance, unit replacement and/or complete engine rebuild, contact the nearest Cummins Distributors to obtain available repair manuals and arrange for training of personnel.

For model identification of an engine, check the dataplate. The letter and number code indicates breathing (naturally aspirated except when letter "T" for turbocharged is present), cubic inch displacement, application and maximum rated horsepower.

Examples:

NTA-855-370	V-903-320
N=4 valve head	V=Type engine
T=Turbocharged	903=Cubic Inch Displacement
A=Aftercooled	320=Maximum Rated horsepower
370=Maximum rated horsepower	

Cummins Engine Company, Inc.
Columbus, Indiana, U.S.A.

Table of Contents

Engine Specifications

Table 1: Agricultural, Construction, Industrial, Logging and Mining Engine Specifications

			Performance Ratings 500 ft. [150 m] 85° F [29° C]			
Engine Model	Configuration Number	Displacement Cu. Inch [liter]	HP [kW]	@ RPM	Peak Torque ft-lbs [N•m]	@ RPM
N-495-C130	D08 1 001 CX01	495 [8.1]	125 [93]	@ 2000	387 [525]	@ 1100
NT-495-C180		495 [8.1]	180 [134]	@ 2100	494 [670]	@ 1500
N-743-C220	D07 1 011 CX01	743 [12.2]	212 [158]	@ 2100	580 [786]	@ 1500
NT-743-C262		743 [12.2]	262 [195]	@ 2100	720 [975]	@ 1400
NT-743-C335		743 [12.2]	335 [250]	@ 2100	900 [1220]	@ 1500
N-855-C220	D09 1 220 CX00	855 [14.0]	220 [164]	@ 2100	644 [873]	@ 1500
N-855-C235	D09 1 215 CX01	855 [14.0]	235 [175]	@ 2100	647 [877]	@ 1500
NT-855-C250	D09 2 294 CX00	855 [14.0]	250 [187]	@ 2100	750 [1017]	@ 1500
NT-855-C280	D09 2 135 CX00	855 [14.0]	280 [209]	@ 2100	805 [1092]	@ 1500
			280 [209]	@ 2100	810 [1098]	@ 1500
NT-855-C310	D09 2 136 CX00	855 [14.0]	310 [231]	@ 2100	890 [1207]	@ 1500
NT-855-C335	D09 2 137 CX00	855 [14.0]	335 [250]	@ 2100	930 [1260]	@ 1500
NTA-855-C360	D09 3 139 CX00	855 [14.0]	360 [269]	@ 2100	990 [1342]	@ 1500
NTA-855-C400	D09 3 295 CX00	855 [14.0]	400 [298]	@ 2100	1150 [1559]	@ 1500
KT-1150-C450	D19 2 005 CX02	1150 [18.9]	450 [336]	@ 2100	1350 [1831]	@ 1500
KTA-1150-C525	D19 3 011 CX02	1150 [18.9]	525 [392]	@ 2100	1575 [2136]	@ 1500
KTA-1150-C600	D19 3 006 CX02	1150 [18.9]	600 [448]	@ 2100	1650 [2237]	@ 1600
V-378-C	D20 1 025 CX00	378 [6.2]	145 [108]	@ 3000	280 [380]	@ 1900
V-504-C	D21 1 031 CX00	504 [8.3]	195 [146]	@ 3000	375 [508]	@ 1900
VT-555-C	D22 2 024 CX00	555 [9.1]	230 [172]	@ 3000	455 [616]	@ 1900
V-903-C265	D17 1 010 CX00	903 [14.8]	265 [198]	@ 2600	657 [891]	@ 1500
V-903-C295	D17 1 034 CX00	903 [14.8]	295 [220]	@ 2600	700 [949]	@ 1800
VT-903-C320	D17 2 009 CX00	903 [14.8]	320 [239]	@ 2600	775 [1051]	@ 1800
VT-903-C350	D17 2 016 CX00	903 [14.8]	350 [261]	@ 2600	848 [1150]	@ 1800
VT-903-C375	D17 2 050 CX00	903 [14.8]	375 [278]	@ 2600	848 [1150]	@ 1800
VT-903-C430	D17 2 045 CX00	903 [14.8]	430 [321]	@ 2500	1000 [1356]	@ 1800
VT-1710-C635	D15 2 014 CX00	1710 [28.0]	635 [474]	@ 2100	1747 [2369]	@ 1500
VTA-1710-C700	D15 3 025 CX00	1710 [28.0]	700 [522]	@ 2100	1925 [2610]	@ 1500
VTA-1710-C800	D16 3 035 CX00	1710 [28.0]	800 [597]	@ 2100	2200 [2983]	@ 1500
KT-2300-C900	D23 2 003 CX02	2300 [37.8]	900 [671]	@ 2100	2475 [1356]	@ 1500

Table 1: Agricultural, Construction, Industrial, Logging and Mining Engine Specifications (Cont'd.)

			Performance Ratings 500 ft. [150 m] 85°F [29°C]	
Engine Model	**Configuration Number**	**Displacement Cu. Inch [liter]**	**HP [kW] @ RPM**	**Peak Torque ft-lbs [N•m] @ RPM**
KTA-2300-C1050	D23 3 004 CX02	2300 [37.8]	1050 [783] @ 2100	2890 [3919] @ 1500
KTA-2300-C1200	D23 3 001 CX02	2300 [37.8]	1200 [895] @ 2100	3300 [4470] @ 1500
KTA-3067-C1600	D28 3 003 CX02	3067 [50.3]	1600 [1194]@ 2100	4400 [5966] @ 1500
			Restricted Availability	
N-855-P190	D09 1 178 PX00	855 [14.0]	190 [142] @ 2100	566 [768] @ 1200
N-855-P220	D09 1 179 PX00	855 [14.0]	220 [164] @ 2100	664 [873] @ 1500
N-855-P250	D09 1 058 PX00	855 [14.0]	240 [179] @ 2100	658 [892] @ 1500
N-855-C190	D09 1 175 CX00	855 [14.0]	190 [142] @ 2100	566 [768] @ 1200
N-855-C220	D09 1 148 CX00	855 [14.0]	220 [164] @ 2100	644 [873] @ 1500
N-855-C250	D09 1 075 CX00	855 [14.0]	240 [170] @ 2100	658 [892] @ 1500
NT-855-C310	D09 2 076 CX00	855 [14.0]	310 [231] @ 2100	860 [1166] @ 1500
NT-855-C335	D09 2 056 CX00	855 [14.0]	335 [250] @ 2100	930 [1261] @ 1500
VTA-903-T	D17 3 020 TX01	903 [14.8]	450 [336] @ 2600	1000 [1356] @ 1900
V-378-C155	D20 1 007 CX00	378 [6.2]	149 [111] @ 3300	289 [392] @ 1900
V-504-C210	D21 1 008 CX00	504 [8.3]	202 [151] @ 3300	387 [525] @ 1900
V-555-C230	D22 1 003 CX00	555 [9.1]	230 [172] @ 3300	425 [576] @ 1900
VT-555-C240	D22 2 016 CX00	555 [9.1]	240 [179] @ 3300	445 [603] @ 1900
VT-555-C250	D22 2 022 CX00	555 [9.1]	250 [187] @ 3300	445 [603] @ 1900
N-495-P130	D08 1 002 PX01	495 [8.1]	125 [93] @ 2000	187 [525] @ 1100
NT-495-P180		495 [8.1]	180 [134] @ 2100	494 [670] @ 1500
N-743-P220	D07 1 016 PX01	743 [12.2]	211 [157] @ 2100	580 [786] @ 1500
NT-743-P335		743 [12.2]	335 [250] @ 2100	900 [1220] @ 1500
N-855-P235	D09 1 276 PX02	855 [14.0]	235 [175] @ 2100	647 [877] @ 1500
N-855-P250	D09 1 058 PX00	855 [14.0]	240 [179] @ 2100	658 [892] @ 1500
NT-855-P310	D09 2 110 PX00	855 [14.0]	310 [231] @ 2100	852 [1155] @ 1500
NT-855-P335	D09 2 059 PX00	855 [14.0]	335 [250] @ 2100	930 [1261] @ 1600
NT-855-P335	D09 2 278 PX02	855 [14.0]	335 [250] @ 2100	930 [1261] @ 1500
NTA-855-P360	D09 3 279 PX02	855 [14.0]	360 [269] @ 2100	990 [1342] @ 1500
NTA-855-P400	D09 3 280 PX02	855 [14.0]	400 [298] @ 2100	1150 [1559] @ 1500
KT-1150-P450	D19 2 018 PX02	1150 [18.9]	450 [336] @ 2100	1350 [1831] @ 1500
KTA-1150-P600	D19 3 019 PX02	1150 [18.9]	600 [448] @ 2100	1650 [2237] @ 1600
V-378-P	D20 1 026 PX00	378 [6.2]	145 [108] @ 3000	280 [380] @ 1900

Table 1: Agricultural, Construction, Industrial, Logging and Mining Engine Specifications (Cont'd.)

			Performance Ratings 500 ft. [150 m] 85° F [29° C]			
Engine Model	Configuration Number	Displacement Cu. Inch [liter]	HP [kW]	@ RPM	Peak Torque ft-lbs [N•m]	@ RPM
V-504-P	D21 1 032 PX00	504 [8.3]	195 [146]	@ 3000	375 [508]	@ 1900
VTA-1710-P700	D15 3 075 PX02	1710 [28.0]	700 [522]	@ 2100	1925 [2610]	@ 1500
VTA-1710-P800	D15 3 076 PX02	1710 [28.0]	800 [597]	@ 2100	2200 [2983]	@ 1500
KT-2300-P900	D23 2 013 PX02	2300 [37.8]	900 [671]	@ 2100	2475 [3356]	@ 1500
KTA-2300-P1200	D23 3 014 PX02	2300 [37.8]	1200 [895]	@ 2100	3300 [4470]	@ 1500
KTA-3067-P1600	D28 3 004 PX02	3067 [50.3]	1600 [1194]	@ 2100	4400 [5966]	@ 1500
V-378-P	D20 1 002 PX00	378 [6.2]	149 [111]	@ 3300	289 [392]	@ 1900
V-504-P	D21 1 003 PX00	504 [8.3]	202 [151]	@ 3300	387 [525]	@ 1900

Table 2: Locomotive and Railcar Engine Specifications

			Performance Ratings 500 ft. [150 m] 85° F [29° C]			
Engine Model	Configuration Number	Displacement Cu. Inch [liter]	HP [kW]	@ RPM	Peak Torque ft-lbs [N•m]	@ RPM
N-855-R2	D09 1 229 RX01	855 [14.0]	235 [175]	@ 2100	650 [881]	@ 1500
N-855-L1	D09 1 217 LX00	855 [14.0]	235 [175]	@ 2100	650 [881]	@ 1500
NT-855-L4	D09 2 199 LX00	855 [14.0]	335 [250]	@ 2100	930 [1261]	@ 1500
NT-855-R4	D09 2 223 RX01	855 [14.0]	335 [250]	@ 2100	930 [1261]	@ 1500
NTA-855-L3	D09 3 296 LX00	855 [14.0]	400 [298]	@ 2100	1150 [1559]	@ 1500
NTA-855-R	D09 3 304 RX01	855 [14.0]	400 [298]	@ 2100	1150 [1559]	@ 1500
KT-1150-L	D19 2 009 LX02	1150 [18.9]	450 [336]	@ 2100	1350 [1831]	@ 1500
KTA-1150-L	D19 3 010 LX02	1150 [18.9]	600 [448]	@ 2100	1650 [2237]	@ 1500
VTA-1710-L1	D15 3 077 LX01	1710 [28.0]	700 [522]	@ 2100	1920 [2604]	@ 1500
VTA-1710-L2	D15 3 078 LX01	1710 [28.0]	800 [597]	@ 2100	2200 [2983]	@ 1500
KT-2300-L	D23 2 006 LX02	2300 [37.8]	900 [671]	@ 2100	2475 [3356]	@ 1500
KTA-2300-L	D23 3 005 LX02	2300 [37.8]	1200 [895]	@ 2100	3300 [4474]	@ 1500
KTA-3067-L	D28 3 004 LX02	3067 [50.3]	1600 [1194]	@ 2100	4400 [5966]	@ 1500
			Restricted Availability			
NHRS-6-L1		743 [12.2]	272 [203]	@ 2100	730 [989]	@ 1600
N-855-R	D09 1 011 RX01	855 [14.0]	240 [179]	@ 2100	648 [892]	@ 1500

Table 3: Fire Pump Engine Specifications

			Performance Ratings Sea Level 60°F [16°C]	
Engine Model	**Configuration Number**	**Displacement Cu. Inch [liter]**	**HP [kW]**	**@ RPM**
N-855-F	D09 1 190 FX01	855 [14.0]	160 [119]	@ 1460
			190 [142]	@ 1750
			200 [149]	@ 1900
			215 [160]	@ 2100
NT-855-F1	D09 2 012 FX01	855 [14.0]	255 [190]	@ 1750
			255 [190]	@ 1900
			255 [190]	@ 2100
NT-855-F2	D09 2 061 FX01	855 [14.0]	285 [212]	@ 1750
			303 [226]	@ 1900
			325 [242]	@ 2100
			340 [254]	@ 2300
V-378-F1	D20 1 017 FX01	378 [6.2]	116 [87]	@ 1750
			135 [101]	@ 2000
			111 [83]	@ 2200
V-378-F2	D20 1 018 FX01	378 [6.2]	118 [88]	@ 2400
			125 [93]	@ 2600
			130 [97]	@ 2800
			133 [99]	@ 3000
			136 [101]	@ 3300
V-504-F1	D21 1 025 FX01	504 [8.3]	121 [90]	@ 1750
			141 [105]	@ 2000
			145 [108]	@ 2200
V-504-F2	D21 1 024 FX01	504 [8.3]	157 [117]	@ 2400
			168 [125]	@ 2600
			174 [130]	@ 2800
			182 [136]	@ 3000
			185 [138]	@ 3300
VT-1710-F	D15 2 053 FX01	1710 [28.0]	435 [324]	@ 1460
			525 [392]	@ 1750
			550 [410]	@ 1900
			580 [433]	@ 2100

Table 4: Engine and Generator Specifications (1800 RPM ratings are 60 HZ., 1500 RPM ratings are 50 HZ.)

Engine Model	Configuration Number	Displacement Cu. Inch [liter]	Performance Ratings 500 ft. [150 m] 85°F [29°C] Stand-By Output KW @ RRM	Cont. Output KW @ RPM
N-855-GS/GC	D09 1 241 GX02	855 [14.0]	135 @ 1800	135 @ 1800
			155 @ 1500	115 @ 1500
NT-855-GS/GC	D09 2 242 GX02	855 [14.0]	230 @ 1800	205 @ 1800
			190 @ 1500	170 @ 1500
NTA-855-GS/GC	D09 3 243 GX02	855 [14.0]	260 @ 1800	235 @ 1800
			220 @ 1500	200 @ 1500
KT-1150-GS/GC	D19 2 013 GX02	1150 [18.9]	300 @ 1800	275 @ 1800
			265 @ 1500	240 @ 1500
KTA-1150-GS/GC	D19 3 015 GX02	1150 [18.9]	365 @ 1800	325 @ 1800
			310 @ 1500	280 @ 1500
VT-1710-GS/GC	D15 2 072 GX02	1710 [28.0]	450 @ 1800	375 @ 1800
			410 @ 1500	335 @ 1500
VTA-1710-GS/GC	D15 3 074 GX02	1710 [28.0]	550 @ 1800	455 @ 1800
			440 @ 1500	400 @ 1500
KT-2300-GS/GC	D23 2 009 GX02	2300 [37.8]	600 @ 1800	535 @ 1800
			500 @ 1500	450 @ 1500
KTA-2300-GS/GC	D23 3 010 GX02	2300 [37.8]	750 @ 1800	
			580 @ 1500	
KTA-3067-GS/GC	D28 3 006 GX02	3067 [50.3]	1000 @ 1800	900 @ 1800
			825 @ 1500	745 @ 1500

Engine Model	Configuration Number	Displacement Cu. Inch [liter]	1800 RPM HP *	[kW]	1500 RPM HP	[kW]
N-855-G	D09 1 241 GX02	855 [14.0]	215	[160]	180	[134]
			(195)	[145]	(160)	[119]
NT-855-G	D09 2 442 GX02	855 [14.0]	355	[265]	295	[220]
			(320)	[239]	(265)	[198]
NTA-855-G	D09 3 243 GX02	855 [14.0]	300	[298]	335	[250]
			(360)	[269]	(300)	[224]
KT-1150-G	D19 2 013 GX02	1150 [18.9]	465	[347]	405	[302]
			(420)	[313]	(365)	[272]
			(415)	[310]	(345)	[257]
KT-1150-G	D19 3 015 GX02	1150 [18.9]	560	[418]	470	[351]
			(505)	[377]	(425)	[317]
			(500)	[373]	(425)	[317]
VT-1710-G	D15 2 072 GX02	1710 [28.0]	685	[511]	620	[463]
			(555)	[414]	(465)	[347]
VTA-1710-G	D15 3 074 GX02	1710 [28.0]	760	[567]	690	[515]
			(680)	[507]	(570)	[425]

Table 4: Engine and Generator Specifications (1800 RPM Ratings are 60 HZ., 1500 RPM ratings are 50 HZ.) (Cont'd.)

			Performance Ratings 500 ft. [150 m] 85° F [29° C]			
			1800 RPM		1500 RPM	
Engine Model	Configuration Number	Displacement Cu. Inch [liter]	HP *	[kW]	HP	[kW]
KT-2300-G	D23 2 009 GX02	2300 [37.8]	915	[683]	760	[567]
			(820)	[611]	(685)	[511]
KTA-2300-G	D23 3 010 GX02	2300 [37.8]	1135	[832]	940	[701]
			(1005)	[749]	(845)	[630]
KTA-3067-G	D28 3 006 GX02	3067 [50.3]	1490	[1112]	1240	[925]
			1350	[1007]	1125	[839]

* ( ) Marine Approved Rating

Operating Instructions

The engine operator must assume responsibility of engine care while engine is being operated. There are comparatively few rules which operator must observe to get best service from a Cummins Diesel.

General—All Applications

New and Rebuilt Engines Break-In

Cummins engines are run-in on dynamometers before being shipped from the factory and are ready to be put to work in applications such as emergency fire trucks and rail car applications.

In other applications, the engine can be put to work, but the operator has an opportunity to establish conditions for optimum service life during initial 100 hours of service by:

1. Operating as much as possible at three-quarter throttle of load range.
2. Avoiding operation for long periods at engine idle speeds, or at maximum horsepower levels in excess of five minutes.
3. Developing the habit of watching engine instruments closely during operation and letting up on throttle if oil temperature reaches 250° F [121° C] or coolant temperature exceeds 190° F [88° C].
4. Operating with a power requirement that allows acceleration to governed speed when conditions require more power.
5. Checking oil level every 10 hours during the break-in period.

New or Rebuilt Engines Pre-Starting Instructions — First Time

Priming The Fuel System

1. Fill fuel filter with clean No. 2 diesel fuel oil meeting the specifications outlined in Section 3.
2. Remove fuel pump suction line and wet gear pump gears with clean lubricating oil.
3. Check and fill fuel tanks.
4. If injector and valve or other adjustments have been disturbed by any maintenance work, check to be sure they have been properly adjusted before starting the engine.

Priming The Lubricating System

Note: On turbocharged engines, remove oil inlet line from the turbocharger and prelubricate bearing by adding 2 to 3 oz. [50 to 60 cc] of clean lubricating oil. Reconnect oil supply line.

1. Fill crankcase to "L" (low) mark on dipstick. See Lubricating Oil Specifications, Section 3.
2. Remove plug from lubricating oil crossover passage on NH/NT-855 Engines, Fig. 1-1. Remove plug from head of lubricating oil filter housing on V Engines, Fig's. 1-2, 1-3, 1-4, 1-5 and 1-6. On KT/KTA-1150 Engines, remove plug from front of oil cooler housing, Fig. 1-7.

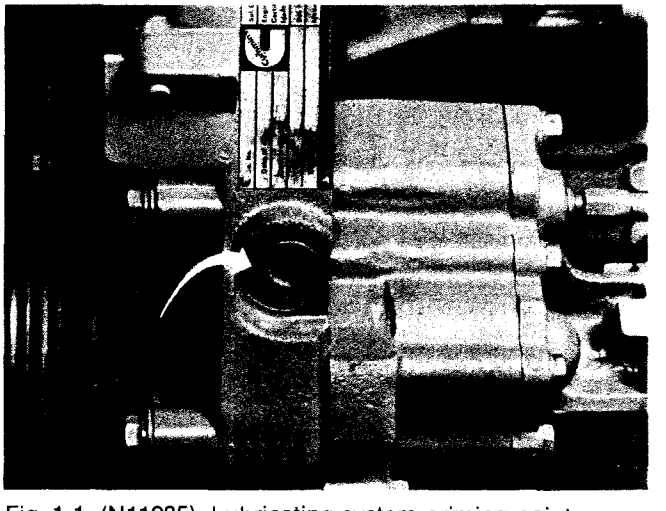


Fig. 1-1, (N11985). Lubricating system priming point — N/NT-855 Engine

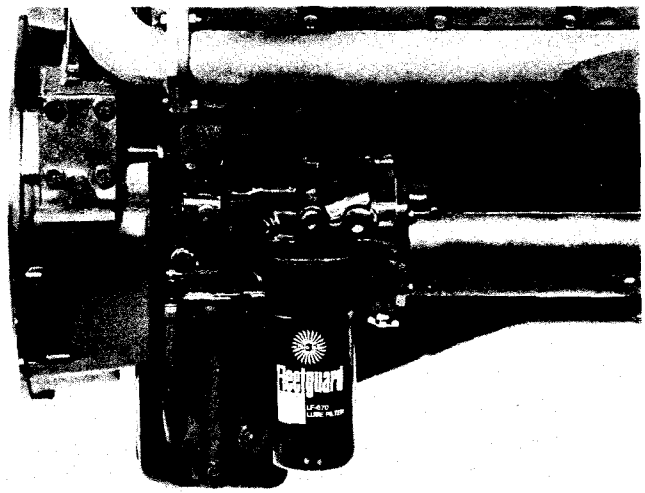


Fig. 1-2, (OM101). Lubricating system priming point — V/VT-903 Engine

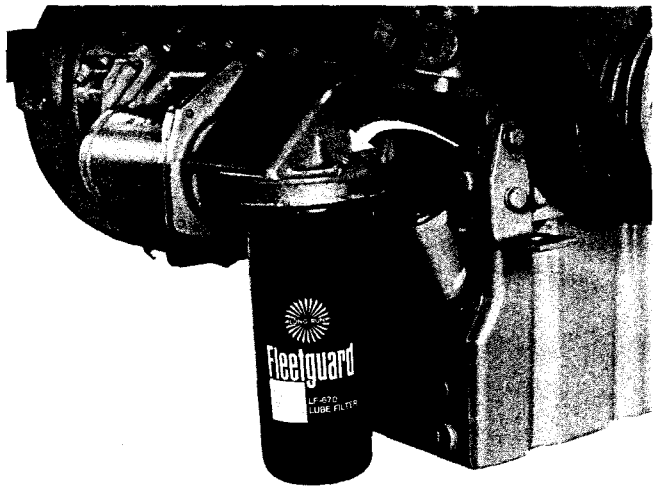


Fig. 1-3, (OM102). Lubricating system priming point — V-378, V-504, V/VT-555 Engines

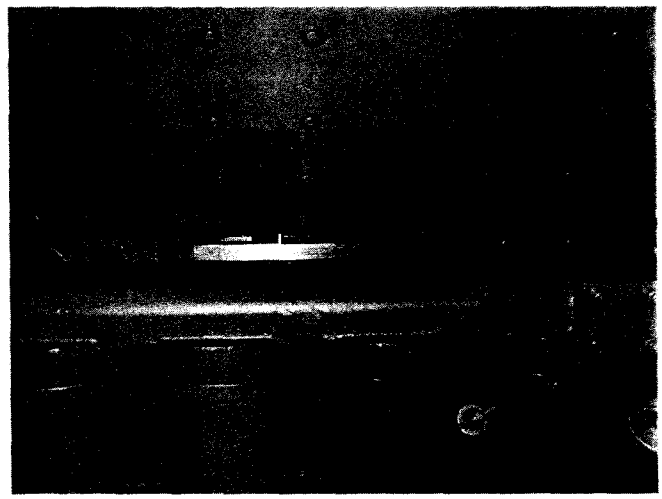


Fig. 1-4, (K21902). Lubricating system priming point — KT(A)-2300 Engine

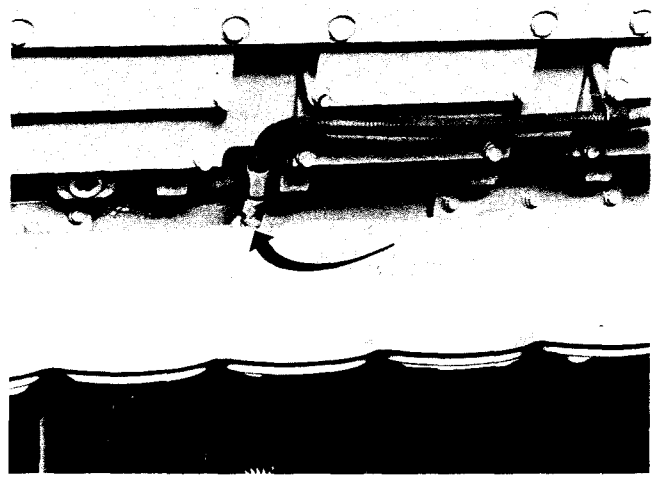


Fig. 1-5, (OM202). Lubricating system priming point — KTA-3067 Engine

Caution: Do not prime engine lubricating system from by-pass filter.

3. Connect a hand- or motor-driven priming pump line from source of clean lubricating oil to plug boss in housing.
4. Prime until a 30 psi [207 kPa] minimum pressure is obtained.
5. Crank engine at least 15 seconds (with fuel shut-off valve closed or disconnected to prevent starting), while maintaining external oil pressure at a minimum of 15 psi [103 kPa].
6. Remove external oil supply and replace plug.

Caution: Clean area of any lubricating oil spilled while priming or filling crankcase.

7. Fill crankcase to "H" (high) mark on dipstick with oil meeting specifications, listed in Section 3. No change in oil viscosity or type is needed for new or newly rebuilt engines.

A dipstick oil gauge is located on the side of the engine. Fig. 1-8. The dipstick has an "H" (high) (1) and "L" (low) (2) level mark to indicate lubricating oil supply. The dipstick must be kept with the oil pan, or engine, with which it was orginally supplied. Cummins oil pans differ in capacity with different type installations and oil pan part numbers.

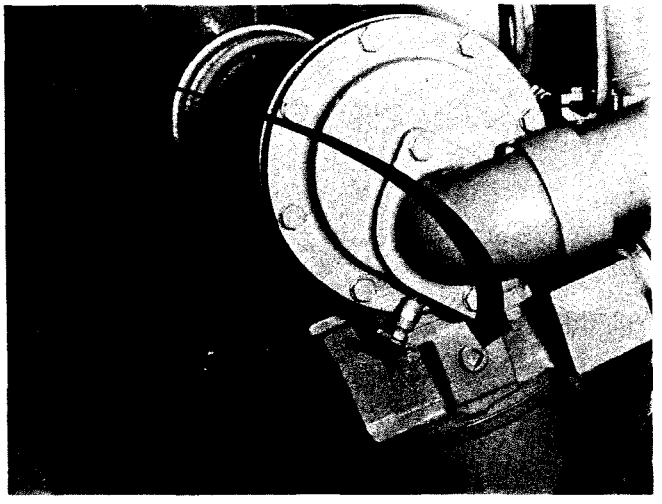


Fig. 1-6, (V41816). Lubricating system priming point — V-1710 Engine

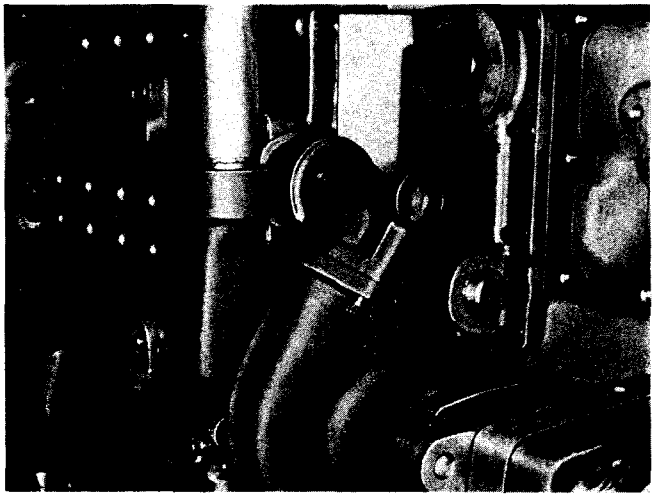


Fig. 1-7, (K11949). Lubricating system priming point — KT(A)-1150 Engine

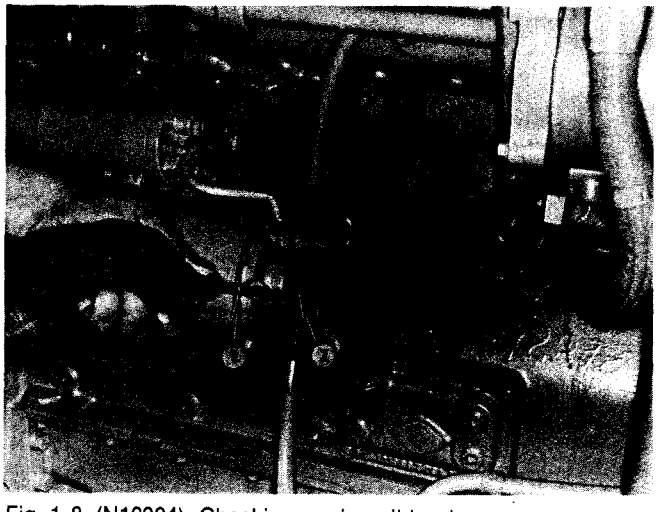


Fig. 1-8, (N12004). Checking engine oil level

Check Hydraulic Governor

Many engines used in stationary power applications are equipped with hydraulic-governed fuel pumps which use lubricating oil as an energy medium, same weight as used in engine. Oil level in governor sump must be at full mark on dipstick.

Check Air Connections

Check air connections to compressor and air equipment, as used, and to air cleaners and air crossovers to assure all are secured.

Check Engine Coolant Supply

1. Remove the radiator or heat exchanger cap and check engine coolant supply. Add coolant as needed.

2. Make visual check for leaks and open water filter shut-off valves.

Starting the Engine

Starting requires that clean air and fuel be supplied to the combustion chambers in proper quantities at the correct time.

Normal Starting Procedure

If fuel system is equipped with overspeed stop, push "Reset" button before attempting to start engine.

1. On units equipped with air activated prelube device, open air valve to activate piston in prelube device which will lubricate all moving parts in engine.

Note: On engines equipped with an oil pressure safety switch, hold the fuel by-pass switch in "start" position until engine oil pressure reaches 7 to 10 psi [48 to 69 kPa]; then, move to "run" position.

2. Set throttle for idle speed and disengage driven unit.

Caution: Protect the turbocharger during start-up by not opening throttle or accelerating above 1000 rpm until idle speed oil pressure registers on gauge.

3. Open manual fuel shut-down valve, if so equipped. Fig. 1-9. Electric shut-down valves operate as switch is turned on. A manual override knob provided on

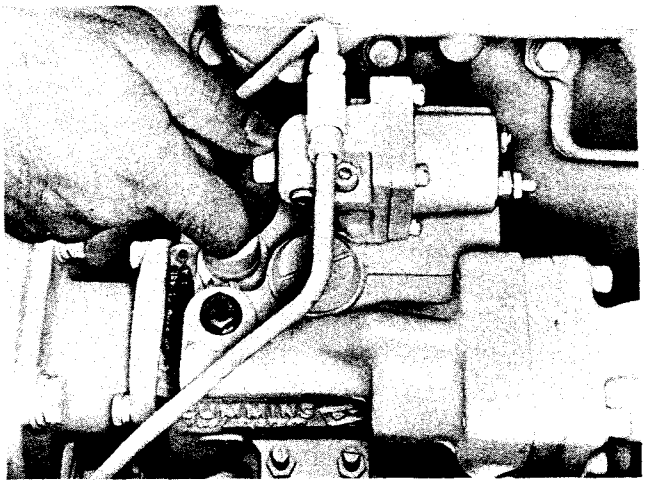


Fig. 1-9, (V21970). Using manual override knob

forward end of electric shut-down valve allows valve to be opened in case of electric power failure. To use, turn fully clockwise; return to run position after electric repair.

Warning: Before starting, check to make sure everyone is clear of engine and equipment to prevent accidents.

4. Pull the compression release (if so equipped) and press starter button or turn switch-key to "start" position. After three or four seconds of cranking, close compression release (if so equipped) and continue to crank until engine fires.

Caution: To prevent permanent cranking motor damage, do not crank engine for more than 30 seconds continuously. If engine does not fire within first 30 seconds, wait one to two minutes before recranking.

5. At the initial start or after oil or filter changes and after engine has run for a few minutes, shut it down and wait 15 minutes for oil to drain back into pan. Check engine oil level again; add oil as necessary to bring oil level to "H" mark on dipstick. The drop in oil level is due to absorption by oil filters. Never operate the engine with oil level below the low level mark or above the high level mark.

Cold-Weather Starting

Preheater

The glow plug system supplies heat to the cylinders so compression temperatures are sufficient to ignite fuel.

To aid in starting engine when temperature is 50°F [10.0°C] or below, an intake air preheater is available.

Preheater equipment consists of a hand-priming pump to pump fuel into intake manifold, and a switch to turn on glow plug which is electrically heated by battery. Fuel burns in intake manifold and heats intake air.

Warning: Do not use vapor in conjunction with preheater. To do so could result in a fire.

To use preheater for cold starting:

1. Set throttle in idle position. Turn glow plug toggle switch to "ON" position. Red indicator light must be on.
2. After red light has been on for 20 seconds, start cranking engine. As soon as engine begins rotating, operate preheater priming pump to maintain 80 to 100 psi [552 to 689 kPa] fuel pressure. Use of primer before the 20-second interval will wet glow plug and prevent heating.
3. If engine does not start within 30 seconds, stop cranking. Wait one or two minutes and repeat cranking operation.
4. After engine starts, pump primer slowly to keep engine idling smoothly. In cold weather this may require 4 to 5 minutes or longer. Do not accelerate engine.
5. When the engine has warmed up so it does not falter between primer strokes, stop pumping. Close and lock primer. Turn off glow plug toggle switch. (Red indicator light will go out.)
6. If engine gives no indication of starting during first three full strokes of preheater pump, touch-check intake manifold for heat. If no heat, check electrical wiring. If wiring is all right, remove 1/8 inch pipe plug (1, Fig. 1-10) from manifold near glow plug and close glow plug manual switch for 15 seconds and observe glow plug through 1/8 inch plug hole. The glow plug should be white hot; if not, connect wiring to a 6- to 12-volt (as used) source and check amerpage; it should be 30 to 32 (minimum). If glow plug is all right, check manual switch and resistor (if used) and replace if necessary.

Note: Preheater priming pump, switches and resistor are located at the instrument panel and are to be checked during engine starting.

Fluid Starting Aid

Starting fluids allow combustion with a lower cylinder temperature since it is a more volatile fuel. A pressurized spray can or a rag wet with fluid will usually provide quick starting as low as —10°F [—23°C].

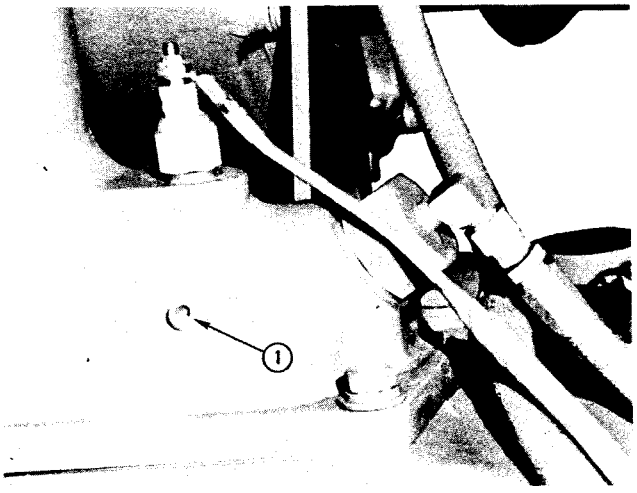


Fig. 1-10, (N11949). Glow plug inspection hole — N/NT-885 Engine

Below this temperature, some means of injecting a carbureted vapor directly into the intake manifold is necessary.

The cold starting aid, approved for use in Cummins Engines, has been based upon starting aid capabilities to —25° F [—32° C].

Caution: Do not attempt to use vapor compound type starting aids near heat, open flame or on engines equipped with glow plug system.

Manually Operated Valve

The manually operated valve, illustrated in Fig. 1-11 includes valve body assembly (6), clamp (2) and nylon tube (3). Fuel cylinder (1), atomizer fitting (5) and pull control (7) must be ordered separately.

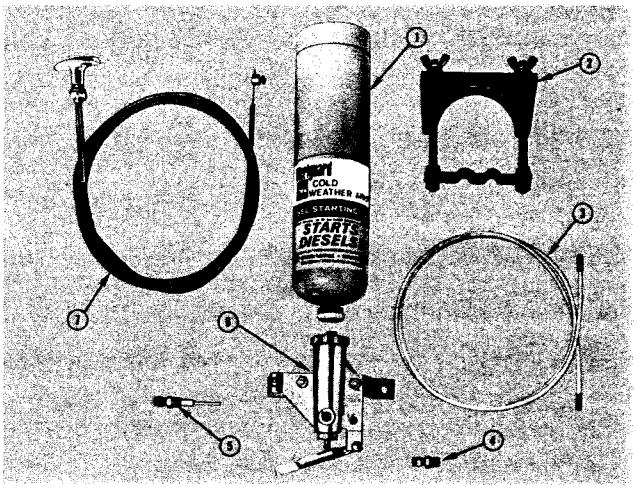


Fig. 1-11, (V11011). Manual operated valve

Standard pull or throttle control cables may be used, to actuate the manual valve, if desired.

Electrically Operated Valve

The electrically operated valve, Fig. 1-12, includes valve body (7), 90 degree elbow (5), clamp (2), push button switch (6), and nylon tube (3). The thermostat is mounted on the engine exhaust manifold and cuts out the valve by sensing manifold heat when the engine is running. See parts catalog for fuel cylinder (1) and fuel atomizer fittings (4). These fittings must be ordered separately, as required.

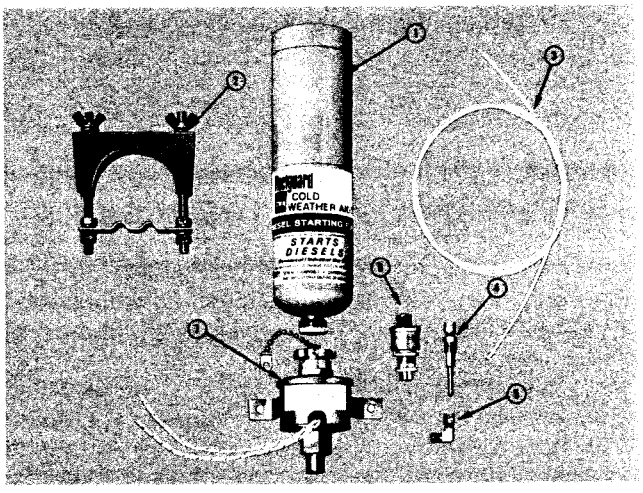


Fig. 1-12, (V11012). Electric operated valve

Installation Recommendations

The atomizer fittings must be mounted in the engine air intake manifold or inlet connection to provide an equal distribution of starting fuel to each cylinder. The atomizer holes are 180 degrees apart and must be mounted so the spray is injected the "long way" of the manifold. If incorrectly installed, the spray goes cross-wise of the manifold.

Recommended Starting Technique Using Fleetguard Starting Aid

1. Set throttle for idle.
2. Disengage driven unit or make sure gears are in neutral.
3. Open manual fuel shut-down valve, or electric shut-down valve, whichever used.
4. Engage starter and while cranking, apply metered amounts of starting fluid until engine idles smoothly.

Use of Starting Fluid Without Metering Equipment

1. Spray starting fluid into air cleaner intake, while second man cranks engine.

Warning: Never handle starting fluid near an open flame. Never use it with preheater or flame thrower equipment. Do not breathe the fumes. Use of too much will cause excessively high pressures and detonation, or over speed engine.

2. Starting aid fumes will be drawn into the air intake manifold and the cold engine should start without difficulty.

Warning: Fuel oil or volatile fuel cold starting aids are not be be used in underground mine or tunnel operations. If the engine is so equipped check with the local U.S. Bureau of Mines Inspector for use of starting aid.

Engine Warm-Up

When the engine is started, it takes a while to get the lubricating oil film re-established between shafts and bearings and between pistons and liners. The most favorable clearances between moving parts are obtained only after all engine parts reach normal operating temperature. Avoid seizing pistons in liners and running dry shafts in dry bearings by bringing the engine up to operating speed gradually as it warms up.

On some emergency equipment (such as fire pump engines) warm-up may not be necessary due to equipment being housed inside a heated building. For an engine starting with a parasitic load, such as a fire pump, coolant temperatures must be a minimum of 120° C [49° C].

Engine Speeds

All Cummins engines are equipped with governors to prevent speeds in excess of maximum or predetermined lower speed rating.

The governor has two functions: First, it provides the fuel needed for idling when the throttle is in idle position. Second, it overrides the throttle and shuts off fuel if engine rpm exceeds maximum rated speed.

Speeds listed in Table 1-1 are for engines rated at maximum rpm and fuel rate.

Note: Engines in many applications are applied at a lower than maximum rated speed; check the serial dataplate.

Power generator units are pre-set to operate at a specific governed rpm.

Table 1-1: Engine Speeds (RPM)

Engine Model	Maximum Rated
All NH, NT, 855-R, 855-L	2100
All NH, NT	2300
V-903	2600
VT-903	2400
V-378, V-504, V-555	3000
V-378, V-504, V-555	3300
V-1710, V-1710-L	2100
KT-1150	2100
KTA-1150	2100
KT-2300	2100
KTA-2300	2100
KTA-3067	2100

Oil Temperature

The oil temperature gauge normally should read between 180° F [82° C] and 225° F [116° C]. Under full load conditions, an oil temperature of 226° F [129° C] for a short period is not cause for alarm.

Caution: Any sudden increase in oil temperature which is not caused by load increase is a warning of possible mechanical failure and should be investigated at once.

During warm-up period, apply load gradually until oil temperature reaches 140° F [60° C]. While oil is cold it does not do a good job of lubricating. Continuous operation or long periods of idle with oil temperatures below 140° F [60° C] may cause crankcase dilution and acids in the lubricating oil which quickly accelerate engine wear.

Water Temperature

A water temperature of 165 to 195° F [74 to 91° C] is the best assurance that working parts of the engine have expanded evenly to the most favorable oil clearances. Maximum engine coolant temperatures should not exceed 200° F [93° C].

Keep thermostats in the engine summer and winter, avoid long periods of idling, and take necessary steps to keep water temperature up to a minimum of 165° F [74° C]. If necessary in cold weather, use radiator shutters or cover a part of the radiator to prevent overcooling.

Oil Pressure

Normal engine oil pressure at 225° F [107° C] are listed in Table 1-2.

Table 1-2: Oil Pressure PSI [kPa]

Engine Series	Idle Speed	Rated Speed
NH, NT, 855-R, 855-L	5/20 [34/138]	40/75 [276/517]
V-903, VT-903	5/25 [34/72]	40/65 [276/448]
V-378, V-504, V-555	10/30 [69/207]	45/85 [310/586]
V-1710, V-1710-L	15 [103]	50 [345]
KTA-1150	15 [103]	45/70 [310/483]
KTA-2300	20 [138]	45/70 [310/483]
KTA-3067	20 [138]	45/70 [310/483]

Note: Individual engines may vary from above normal pressures. Observe and record pressure when engine is new to serve as a guide for indication of progressive engine condition. (High oil pressure during start-up is not cause for alarm.) For record purposes these readings are more accurate and reliable when taken immediately after an oil change.

Engine Exhaust

The engine exhaust is a good indicator of engine operation and performance. A smoky exhaust may be due to a poor grade of fuel, dirty air cleaner, over-fueling or poor mechanical conditions.

If engine exhaust is smoky, corrective action should be taken.

High Altitude Operation

Some engines, particularly naturally aspirated, lose horsepower when operated at high altitude because the air is too thin to burn as much fuel as at sea level. This loss is about 3 percent for each 1000 ft [304.8 m] of altitude above sea level for a naturally aspirated engine. Operate using a lower power requirement at high altitude to prevent smoke and over-fueling.

Power Take-Off Application With PT (type G) VS Fuel Pump

The VS fuel pump governor lever is used to change standard governed speed of engine from rated speed to an intermediate power take-off speed.

When changing from standard speed range to power take-off speed with engine idling on standard throttle, operate as follows:

1. Place the VS speed control lever in operating position.
2. Lock the standard throttle in full-open position.
3. Engage power take-off.

To return to standard throttle:

1. Disengage power take-off.
2. Return standard throttle to idle position.
3. Lock the VS speed control lever in maximum speed position.

Engine Shut-Down

Idle Engine A Few Minutes Before Shut-Down

It is important to idle an engine 3 to 5 minutes before shutting it down to allow lubricating oil and water to carry heat away from the combustion chamber, bearings, shafts, etc. This is especially important with turbocharged engines.

The turbocharger contains bearings and seals that are subject to the high heat of combustion exhaust gases. While the engine is running, this heat is carried away by oil circulation, but if the engine is stopped suddenly, the turbocharger temperature may rise as much as 100° F [56° C]. The results of extreme heat may be seized bearings or loose oil seals.

Do Not Idle Engine for Excessively Long Periods

Long periods of idling are not good for an engine because combustion chamber temperatures drop so low the fuel may not burn completely. This will cause carbon to clog the injector spray holes and piston rings and may result in stuck valves.

If engine coolant temperature becomes too low, raw fuel will wash lubricating oil off cylinder walls and dilute crankcase oil so all moving parts of the engine will suffer from poor lubrication.

If the engine is not being used, shut it down.

Turn Switch Key to "Off" Position to Shut Down the Engine

The engine can be shut down completely by turning off the switch key on installations equipped with an electric shut-down valve, or by turning the manual shut-down valve knob. Turning off the switch key

which controls the electric shut-down valve always stops the engine unless override button on shut-down valve has been locked in open position. If manual override on electric shut-down valve is being used, turn button fully counterclockwise to stop engine. Refer to "Normal Starting Procedure". Valve cannot be reopened by switch key until after engine comes to complete stop.

Caution: Never leave switch key or override button in valve open or in run position when engine is not running. With overhead tanks this would allow fuel to drain into cylinders, causing hydraulic lock.

Do Not Use the Compression Release Lever to Stop the Engine

Some engines are equipped with a compression release lever. Pulling this lever lifts the intake or exhaust (depending on engine model) valve push tubes and opens the valves. The push tubes are lifted off their sockets and extensive wear on the balls and sockets will result from using the compression release to stop the engine.

The compression release lever can be used as an aid in cranking, before starting, or while making injector and valve adjustment, but not to stop the engine.

Stop Engine Immediately If Any Parts Fail

Practically all failures give some warning to the operator before the parts fail and ruin the engine. Many engines are saved because alert operators heed warning signs (sudden drop in oil pressure, unusual noises, etc.) and immediately shut down the engine.

Cold-Weather Protection

1. For cold-weather operation, use of permanent-type antifreeze with rust inhibitor additives is recommended. See Section 3.
2. Drain cylinder block and heads on all engines by opening petcocks and removing drain plugs as shown in Fig's. 1-13 to 1-19. If an air compressor (Fig. 1-20), heat exchanger or other "water cooled" accessory is used, open petcock and drain. Failure to properly drain engine and accessories may cause serious damage during freezing weather.
3. Immersion-type water and oil heaters are available for engines used in cold-weather operations and to maintain temperatures to permit the engine to operate at full load at start-up.

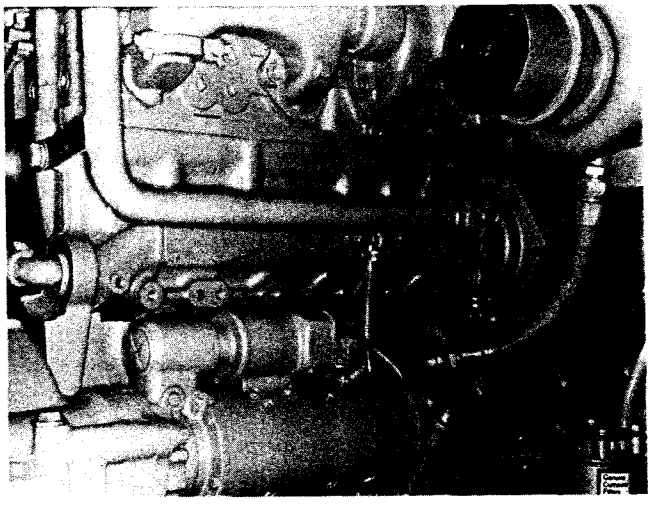


Fig. 1-13, (V100124). Coolant drain point — N/NT-855 Engine

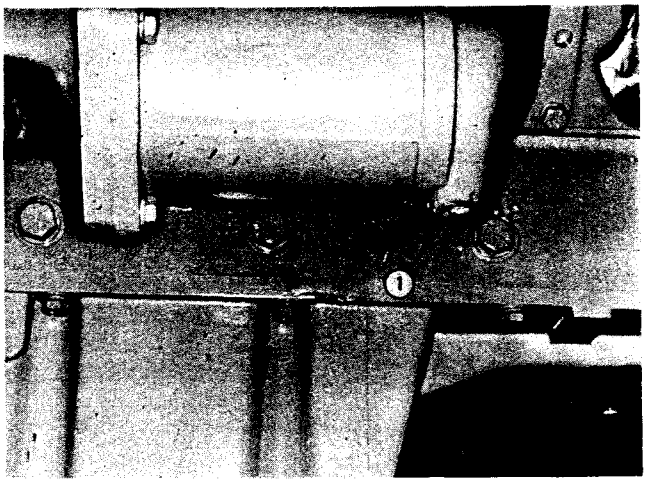


Fig. 1-14, (V50056). Coolant drain point — V/VT-903 Engine

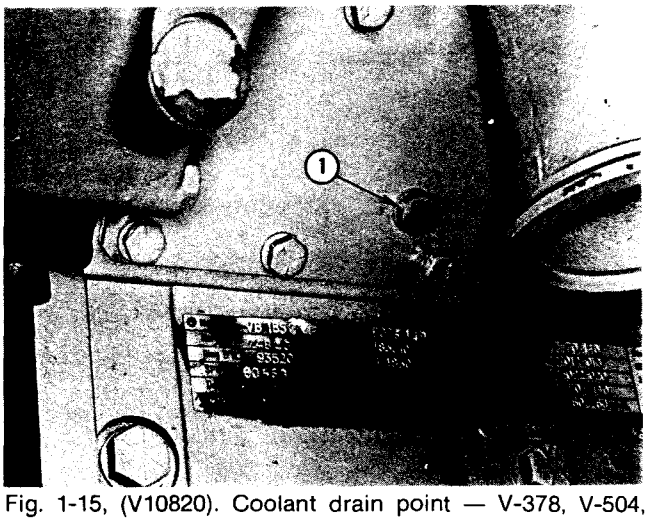


Fig. 1-15, (V10820). Coolant drain point — V-378, V-504, V/VT-555 Engines

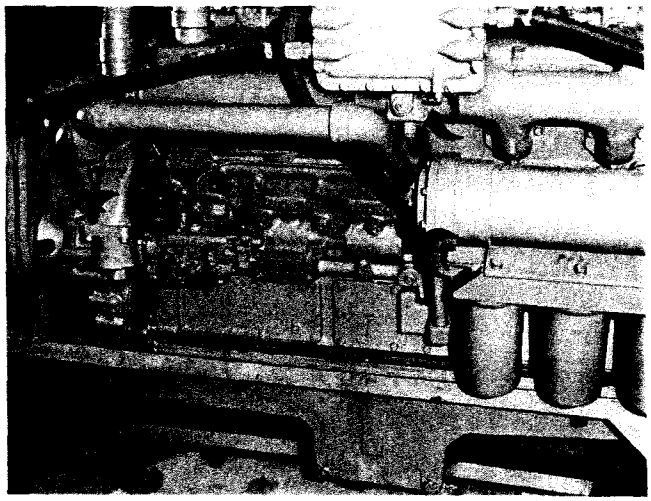


Fig. 1-16, (V40033). Coolant drain point — V/VT-1710 Engine

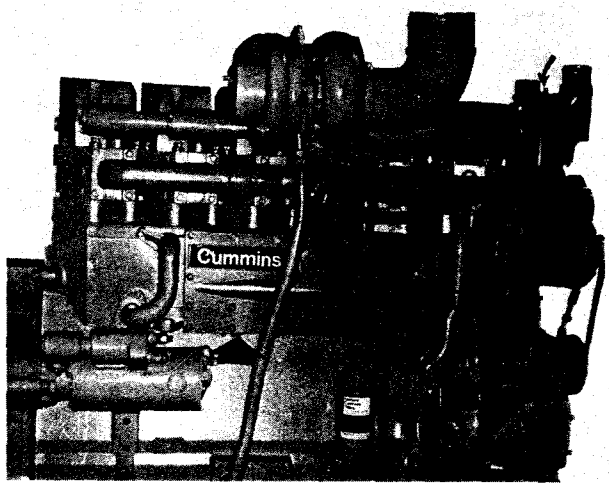


Fig. 1-17, (K11950). Coolant drain point — KT(A)-1150 Engine

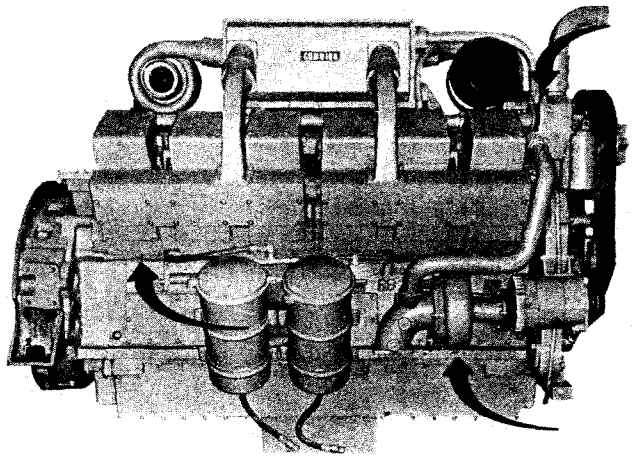


Fig. 1-18, (K21903). Coolant drain point — KT(A)-2300 Engine

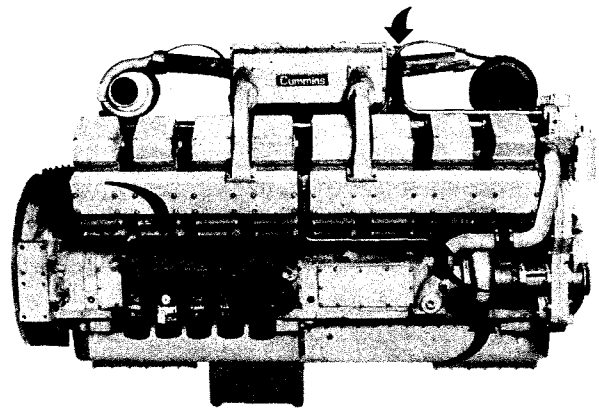


Fig. 1-19, (OM203). Coolant drain point — KTA-3067 Engine

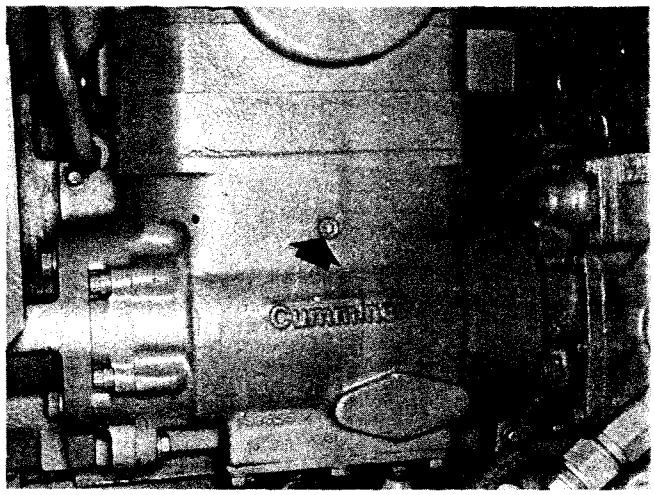


Fig. 1-20, (K21904). Two cylinder air compressor coolant drain

Engine Operation in Cold Weather

Satisfactory performance of a diesel engine operating in low ambient temperature conditions requires modification of the engine, surrounding equipment, operating practices and maintenance procedures. The colder the temperatures encountered the greater the amount of modification required and yet with the modifications applied, the engines must still be capable of operation in warmer climates without extensive changes. The following information is provided to engine owners, operators and maintenance personnel on how the modifications can be applied to get satisfactory performance from their diesel engines.

There are three basic objectives to be accomplished:

1. Reasonable starting characteristics followed by

practical and dependable warm-up of engine and equipment.

2. A unit or installation which is as independent as possible from external influences.
3. Modifications which maintain satisfactory operating temperatures with a minimum increase in maintenance of the equipment and accessories.

If satisfactory engine temperature is not maintained, higher maintenance cost will result due to increased engine wear, poor performance and formation of excessive carbon, varnish and other deposits. Special provisions to overcome low temperatures are definitely necessary, whereas a change to warmer climate normally requires only a minimum of revision. Most of the accessories should be designed in such a way that they can be disconnected so there is little effect on the engine when they are not in use.

The two most commonly used terms associated with preparation of equipment for low temperature operation are "Winterization" and "Arctic Specifications".

Winterization of the engine and/or components so starting and operation are possible in the lowest temperature to be encountered requires:

1. Use of correct materials.
2. Proper lubrication, low temperature lubricating oils.
3. Protection from the low temperature air. The metal temperature does not change, but the rate of heat dissipation is affected.
4. Fuel of proper grade for lowest temperature.
5. Heating to be provided to increase engine block and component temperature to a minimum of —25° F [—32° C] for starting in lower temperatures.
6. Proper external heating source available.
7. Electrical equipment capable of operating in lowest expected temperature.

Arctic specifications refer to the design material and specifications of components necessary for satisfactory engine operation in extreme low temperatures to —65° C] [—54° C]. Contact Cummins Engine Company, Inc., or the equipment manufacturer to obtain the special items required.

Caution: "Anti-leak" antifreezes are not recommended for use in Cummins Engines. Although these antifreezes are chemically compatible with DCA water treatment, the "anti-leak" agents may clog the coolant filters and render them ineffective.

Industrial Fire Pump Engines

Fire pump engines are built and applied under conditions set down by agencies such as Underwriters Laboratory; therefore, parts originally supplied must not be deviated from without qualifying agency approval. The following instructions are those special items necessary to this application, and should be used in conjunction with those previously stated.

Initial Start-Up

Note: Contact operating personnel responsible for fire protection system before starting. Obtain approval to service or repair. After repair obtain authorized signature of acceptance.

1. Remove heat exchanger cap, check or fill engine coolant supply; open water filter inlet and outlet valves.
2. Prelubricate engine with oil metering specification MIL-L-46152 (API-CC/SC) viscosity 10W30. This includes removal of turbocharger oil inlet line on turbocharged engines to prelubricate housing by adding 2 to 3 oz [60 cc] of clean engine lubricating oil.
3. Check crankcase oil level and fill to high mark on dipstick.
4. Remove fuel pump solenoid lead and crank engine through both cranking cycles.
5. If engine is equipped with "Vernier throttle", place in idle position; if not place MVS throttle in idle position. On turbocharged models the delay cylinder line may be disconnected at the block and the block opening plugged.
6. Reconnect fuel solenoid lead and start engine; run at idle speed.
7. Verify lubricating oil pressure has been established, normally in 6 to 8 seconds.

Note: Some automatic controllers require lubricating oil pressure higher than the normal pressure at 600 rpm idle. Increase idle to 800 to 900 rpm if this condition is encountered. All turbocharged engines should be set to 800 to 900 rpm idle.

8. Continue to operate engine 3 to 5 minutes and review all systems for leaks or unusual conditions; correct as required.
9. Stop the engine and install ST-1224 Adapter.
10. Check crankcase oil level and fill to high mark.
11. Start engine and adjust overspeed.
12. Remove ST-1224 and replace original adapter.
13. Clean raw water strainer.
14. Start engine and adjust operating speed.
15. Adjust raw water pressure regulator.
16. Engine is now ready for normal operation.

Normal Operation

1. Daily or normal operation would include checking of fuel, lubricating oil, coolant and correcting any leaks or unusual conditions as required.
2. Check coolant and oil heaters to assure at least 120°F [49°C] water temperature has been maintained.
3. Manually start engine using prescribed starting procedure.
4. Operate engine the prescribed period of time or 5 minutes after stabilization of coolant temperature.
5. Shut engine down using normal test shut-down procedures.

Note: To extend engine operating life and prevent premature component failures it is recommended the engine speed be reduced to idle for 3 to 5 minutes prior to engine shut-down. After shutting down the engine, return speed control to full open position.

Fire Pump Engines — Overspeed Switch Adjustment (IF Engine Models)

The speed switches required for overspeed protection on fire pump engines require high speed for the overspeed adjustment. All engines are now being shipped adjusted at maximum overspeed. The following overspeed adjustments are 20 percent above rated engine speed.

An adapter, ST-1224 with 2:1 ratio, in speed switch drive only, (1, Fig. 1-20) is available to drive the speed switch at twice engine speed. This tool when installed in place of the existing adapter permits adjustment to be made to the speed switch at slightly over 1/2 engine and pump speed. This maintains a pump speed well within its safe speed range while adjustments are being made.

Table 1-3: Engine Overspeeds

Engine Model	Rated Speed	Overspeed
V-378-F1	1750-2200	2100-2640
V-378-F2	2400-3300	2880-3960
V-504-F1	1750-2200	2100-2640
V-504-F2	2400-3300	2880-3960
N-855	1460-2100	1750-2520
NT-855-F1	1750-2100	2100-2520
NT-855-F2	1750-2300	2100-2760
VT-1710-F	1750-2100	2100-2520

Adjustment Procedure

1. Remove present tachometer drive adapter.
2. Install service tool, ST-1224, in position of standard drive adapter. Connect tachometer and overspeed stop switch to the ST-1224 Tool.

Note: Overspeed stop switch cable must be connected to short adapter connection. (1, Fig. 1-21.)

3. Start engine and warm to operating temperature.
4. Set engine speed to one-half (1/2) the desired engine shut-down speed as indicated by tachometer.
   a. On inline engine models, this can be accomplished by adjusting Vernier throttle control.
   b. On Medium Duty V engines, the speed adjustment must be made by adjusting the governor idle and maximum speed screws. The idle screw is housed in the front of the MVS governor. The maximum speed screw is mounted to the MVS governor by a bracket and is on the left hand side of the fuel pump. Engine slow down is accomplished by turning the idle speed screw counterclockwise and turning the maximum speed screw in a clockwise direction. To increase engine speed reverse the procedure.
5. Set single element speed switch.
   a. Remove lockwire from setscrews on side of switch. Loosen three (3) setscrews.
   b. Rotate cover clockwise (this decreases trip speed) until switch actuates and stops engine.
   c. Secure setscrews and replace locking wire.
   d. On manual reset models, re-activate the switch by pushing the reset button on top of switch.
6. Set dual element speed switches.

Caution: Do not break or remove lockwire.

   a. Remove the round head dust cover screw marked 2 from top of switch. Fig. 1-22.
   b. Insert 1/16 inch Hex Allen wrench into adjusting screw located just below surface of cover.

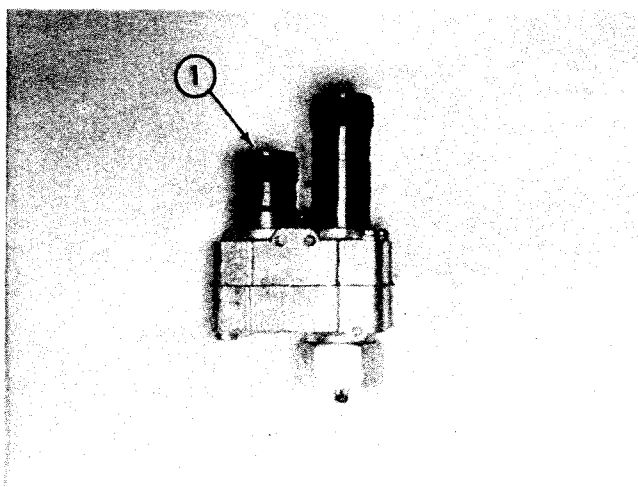


Fig. 1-21, (ST-1224). ST-1224 adapter

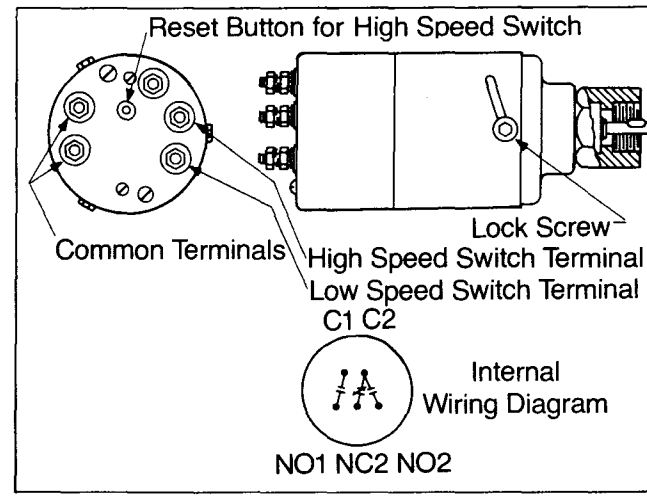


Fig. 1-22, (CGS27). Double speed switch

c. Turn counterclockwise to lower the engine shut-down speed. Turn clockwise to raise engine shut-down speed.

Caution: Do not turn adjusting screw more than three (3) revolutions in either direction from factory setting. Do not attempt to set dual element switch in same manner as the single element switch.

d. Replace the dust cover screw removed in "Step a" above.

e. All overspeed switches must be manually reset, reactivate the switch by pushing the reset button on top of switch.

7. Replace service tool, ST-1224, with original drive adapter and reconnect cables.

Note: If stop crank adjustment is required do not use ST-1224 Adapter. Replace with standard adapter to effect adjustment.

Fire Pump Engine Operating Speed Adjustment

All Cummins fire pump engines will be shipped adjusted at the following speeds unless prior approval has been established for a specific speed.

Final operating speed adjustment should be made at the time of the in service inspection to obtain the required fire pump operating speed.

This speed adjustment must be made with the Vernier throttle in full fuel position and the systems fire pump operating at its rated condition. All speed ranges of N-NT and V-12 models are available by adjusting the MVS high speed adjusting screw. Fig's. 1-23 and 1-24.

Table 1-4: Fire Pump Engine Operating Speed

Engine Model	Fuel Pump Code	Factory Adjusted Speed	Maximum Operating Speed
V-378 F1	C-653	1750	2200
V-378 F2	C-651	2400	3300
V-504 F1	C-652	1750	2200
V-504 F2	C-650	2400	3300
N-855	8761	1750	2100
NT-855 F1	8770	1750	2100
NT-855 F2	8771	1750	2300
VT-1710 F	8784	1750	2100

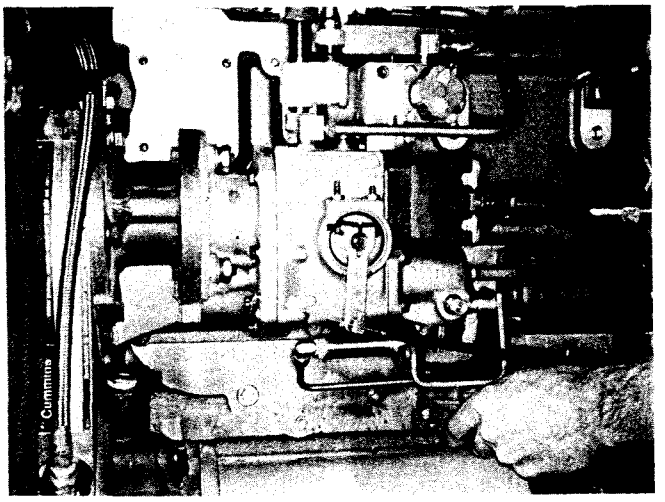


Fig. 1-23, (N11979). Adjusting engine speed

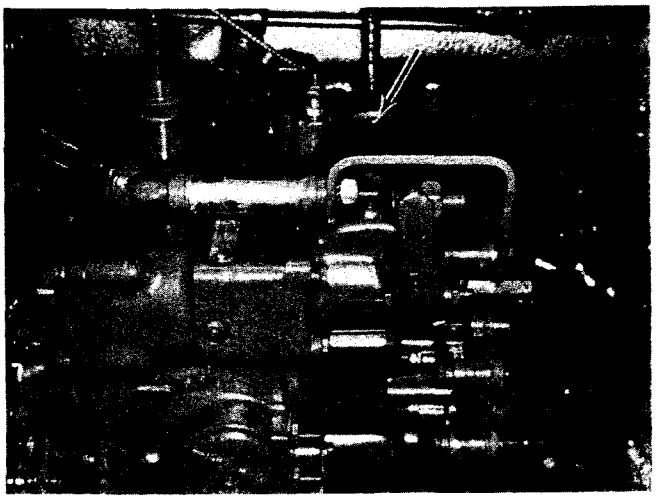


Fig. 1-24, (N11980). Governor adjusting screw

This screw requires a 1/8 inch Allen wrench and adjustment is made by loosening 7/16 inch locking nut and backing screw out to increase engine speed through the full speed range.

The V-378 and V-504 F1 and F2 models require two differently calibrated fuel pumps. One pump code provides speeds between 1750 and 2300 rpm. A different pump code is required for speeds between 2400 and 3300 rpm. The required speeds on these models are similarly obtained by MVS adjustment within the calibrated range as indicated above. It normally is prohibited by UL and FM to change engine ratings by changing fuel pumps on any models of fire pump engines. In the event of fuel pump rebuild, the pump must be calibrated to the original code and **any deviation would be a violation to the insurance agencies approval.**

Industrial Fire Pump Engine Maintenance Schedule

EQUIPMENT NO. _____ ENGINE SERIAL NO. _____
MECHANIC _____ HOURS, CALENDAR _____
TIME SPENT _____ CHECK PERFORMED _____
PARTS ORDER NO. _____ DATE _____

CUMMINS DIESEL FIRE PUMP ENGINES

Check each operation as performed.

A—CHECK

Daily

- ☐ Check engine operating log
- ☐ Check engine:
  - oil level
  - coolant level
- ☐ Check engine lubricating oil and coolant heaters
- * • oil bath cleaner oil level
- ☐ Visually inspect engine for damage, leaks, loose or frayed belts

Weekly

- ☐ Repeat Daily "A" Check
- ☐ Check air cleaner
  - clean precleaner dust pan
  - check restriction indicator
  - clean/change air cleaner element
- * • change oil bath cleaner oil
- ☐ Drain water/sediment from fuel tanks & fuel filters
- ☐ Check raw water strainer
- ☐ Check starter battery
- ☐ Start engine & check for unusual noise

B—CHECK

Repeat "A" (Daily/Weekly)

- ☐ Change engine oil
- ☐ Change filters
  - oil full flow
  - fuel filter
- ☐ Check coolant
  - check engine coolant DCA concentration level. Add make-up DCA and change element if required
- ☐ Clean/change
  - crankcase breather
- * Clean oil bath air cleaner tray/screen

C—CHECK

Repeat "A" & "B"

- ☐ Adjust valves & injectors
- * Clean oil bath air cleaner

D—CHECK

Repeat "A", "B" & "C"

- ☐ Clean & calibrate injectors, fuel pump
- ☐ Check and/or rebuild and/or replace the following assemblies:
  - turbocharger
  - vibration damper
- ☐ Rebuild or replace the following assemblies:
  - water pump

SEASONAL

Fall

- ☐ Clean & flush cooling system
- ☐ Replace hose as required
- ☐ Check cold start & thermal aids
- ☐ Clean electrical connections and check batteries
- ☐ Clean engine water heater

Spring

- ☐ Steam clean engine
- ☐ Tighten mounting bolts
- ☐ Check crankshaft end clearance
- ☐ Check heat exchanger zinc plugs annually or as required
- ☐ Check overspeed switch

OTHER

Electrical Components

- ☐ + Starter
- ☐ + Alternator
- ☐ + Batteries
- ☐ + Voltage regulator
- ☐ + Switches
- ☐ + Gauges
- ☐ + Tachometer

☐ + On these components follow the manufacturer's procedure

Engine Series	Interval	B	C	D
All	Hours Calendar	250 6 mos.	1500 1 year	4500 2 years

Note: Under circumstances where hours of operation are not accumulated at a fast rate, use calendar time. In other words, use hours, or calendar time, whichever comes first.

***Cummins Engine Company, Inc., recommends the use of dry type air cleaners.**

Maintenance

Maintenance is the key to lower operating costs. A diesel engine requires regularly scheduled maintenance to keep it running efficiently.

Maintenance Schedule

Preventive maintenance is the easiest and least expensive type of maintenance. It permits the Maintenance Department to do the work at a convenient time.

A Good Maintenance Schedule Depends on Engine Application

Actual operating environment of the engine governs the maintenance schedule. The suggested check sheet on the following page indicates some checks have to be performed more often under heavy dust or other special conditions.

Using the Suggested Schedule Check Sheet

The maintenance schedule check sheet is designed as a guide until adequate experience is obtained to establish a schedule to meet a specific operation.

A detailed list of component checks is provided through several check periods; also a suggested schedule basis is given for hours of operation, or calendar of time.

A maintenance schedule should be established using the check sheet as a guide; the result will be a maintenance program to fit a specific operation.

The check sheet shown can be reproduced by any printer. The person making each check can then indicate directly on the sheet that the operation has been completed. When a complete column (Under A, B, C, etc.) of checks is indicated, the engine will be ready for additional service until the next check is due.

Storage for Engines Out of Service

If an engine remains out of service and its use is not immediately forthcoming, special precautions should be taken to prevent rust. Contact the nearest Cummins Distributor or consult applicable Shop Manual for information concerning engine storage procedure.

Maintenance Schedule

EQUIPMENT NO. _____ ENGINE SERIAL NO. _____
MECHANIC _____ HOURS, CALENDAR _____
TIME SPENT _____ CHECK PERFORMED _____
PARTS ORDER NO. _____ DATE _____

CUMMINS DIESEL ENGINES

Check each operation as performed.

A—CHECK

Daily

- ☐ Check operator's report
- ☐ Check engine:
  - Oil level
  - Coolant level
- * • Oil bath cleaner oil level
- ☐ Visually inspect engine for damage, leaks, loose or frayed belts and listen for unusual noises

Weekly

- ☐ Repeat Daily "A" Check
- ☐ Check air cleaner
  - Clean precleaner dust pan
  - Check restriction indicator
  - Clean/change air cleaner element
- * • Change oil bath cleaner oil
- ☐ Drain air tanks
- ☐ Drain water/sediment from fuel tanks and fuel filters

B—CHECK

Repeat "A" (Daily/Weekly)

- ☐ Change engine oil
- ☐ Change filters
  - Oil full flow
  - Oil by-pass
  - Fuel filter
- ☐ Check coolant
  - Check engine coolant DCA concentration level. Add make-up DCA and change element if required
- ☐ Check oil levels
  - Aneroid
  - Hydraulic governor
- ☐ Clean/change
  - Crankcase breather—All except KT/KTA-2300 and 3067
  - Air compressor breather
- * ☐ Clean oil bath air cleaner tray/screen

C—CHECK

Repeat "A" & "B"

- ☐ Adjust valves & injectors
- ☐ Change oil
  - Aneroid
  - Hydraulic governor
- ☐ Replace aneroid breather
- ☐ Inspect back side idler
- * ☐ Clean oil bath air cleaner

D—CHECK

Repeat "A", "B" & "C"

- ☐ Clean & calibrate injectors, fuel pump and aneroid
- ☐ Check and/or rebuild and/or replace the following assemblies:
  - Turbocharger
  - Vibration damper
  - Air compressor
- ☐ Rebuild or replace the following assemblies:
  - Fan hub
  - Idler pulley assembly
  - Water pump
  - Back side idler
- ☐ Clean/change crankcase breather on KT/KTA-2300 and 3067

SEASONAL

Fall

- ☐ Clean and flush cooling system
- ☐ Replace hose as required
- ☐ Check cold start & thermal aids
- ☐ Clean electrical connections and check batteries

Spring

- ☐ Steam clean engine
- ☐ Tighten mounting bolts
- ☐ Check crankshaft end clearance
- ☐ Check heat exchanger zinc plugs annually or as required

OTHER

- ☐ + Alternator
- ☐ + Generator
- ☐ + Starter
- ☐ + Exhaust brake
- ☐ + Air compressor
- ☐ + Electrical connections
- ☐ + Batteries
- ☐ + Freon compressor

+ On these components follow the manufacturer's recommended maintenance procedure

Engine Series	Interval	B	C	D		
All	Hours Calendar	Chart Method or 250 6 mos.	1500 1 year	4500 2 years		

Note: Under circumstances where hours of operation are not accumulated at a fast rate, use calendar time. In other words, use hours, or calendar time, whichever comes first.

***Cummins Engine Company, Inc., recommends the use of dry type air cleaners.**

Maintenance Performance Record

Engine Serial No. _____ Engine Model _____

Owner Name _____ Equipment Name/Number _____

Interval Basis Mileage	[Kilometres]	Check	Mileage	[Kilometres]	Check	Other	Date	Actual Mileage	Distributor/Dealer Location/Shop	Authorized Signature
		A, B			A, B					
		A, B			A, B					
		A, B			A, B					
		A, B			A, B					
		A, B, C								
		A, B			A, B, C					
		A, B			A, B					
		A, B			A, B					
		A, B			A, B					
		A, B, C			A, B					
		A, B								
		A, B			A, B, C					
		A, B			A, B					
		A, B			A, B					
		A,B,C,D			A, B					
		A, B			A, B					
		A, B			A,B,C,D					

To prove that the Engine has been properly maintained retain records, such as work orders and receipts, showing that scheduled maintenance has been performed. The maintenance record form on this page is for that purpose.

"A" Maintenance Checks—Daily

Make a Daily Report of Engine Operation to the Maintenance Department

The engine must be maintained in top mechanical condition if the operator is to get optimum satisfaction from its use. The maintenance department needs daily running reports from the operator to make necessary adjustments in the time allotted and to make provisions for more extensive maintenance work as the reports indicate the necessity.

Comparison and intelligent interpretation of the daily report along with a practical follow-up action will eliminate most failures and emergency repairs.

Report to the Maintenance Department any of the following conditions:

1. Low lubricating oil pressure.
2. Low power.
3. Abnormal water or oil temperature.
4. Unusual engine noise.
5. Excessive smoke.
6. Excessive use of coolant, fuel or lubricating oil.
7. Any fuel, coolant or lubricating oil leaks.

Check Engine

Check Engine Oil Level

Note: Some dipsticks have dual markings, with high- and low-level marks: static oil marks on one side, engine running at low idle speed marks on opposite side. Be sure to use proper scale.

1. Check oil level with dipstick oil gauge located on the engine. Fig. 2-1. For accurate readings, oil level should not be checked for approximately 15 minutes after engine shut-down. Keep dipstick with the oil pan with which it was originally shipped. Keep oil level as near "H" (high) mark as possible.

Caution: Never operate the engine with oil level below the "L" (low) mark or above the "H" (high) mark.

2. If necessary, add oil of the same quality and brand as already in the engine. See Section 3.

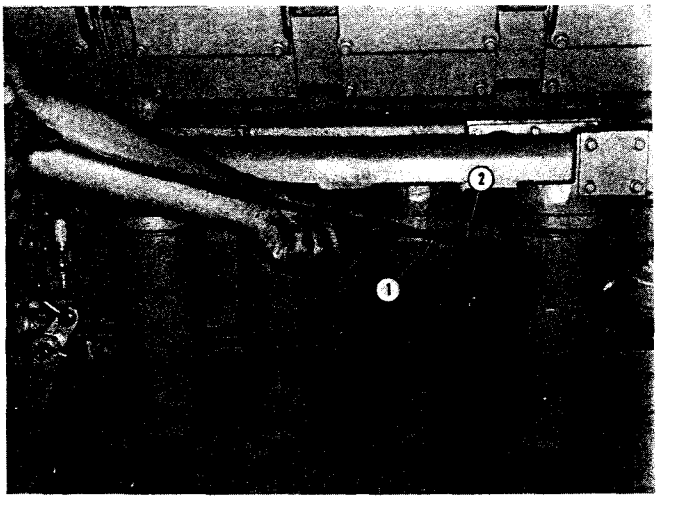


Fig. 2-1, (K21901). Checking engine oil level

Check Engine Coolant Level

Keep cooling system filled to operating level. Check coolant level daily or at each fuel fill point. Investigate for causes of coolant loss. Check coolant level only when system is cool.

Check Belts

Visually check belts for looseness. If there is evidence of belt slippage adjust as follows:

Using appropriate gauge, Fig's. 2-2 and 2-3, check

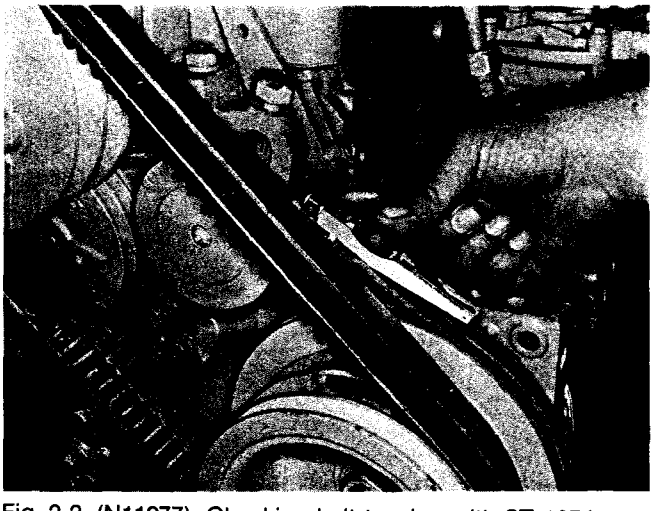


Fig. 2-2, (N11977). Checking belt tension with ST-1274

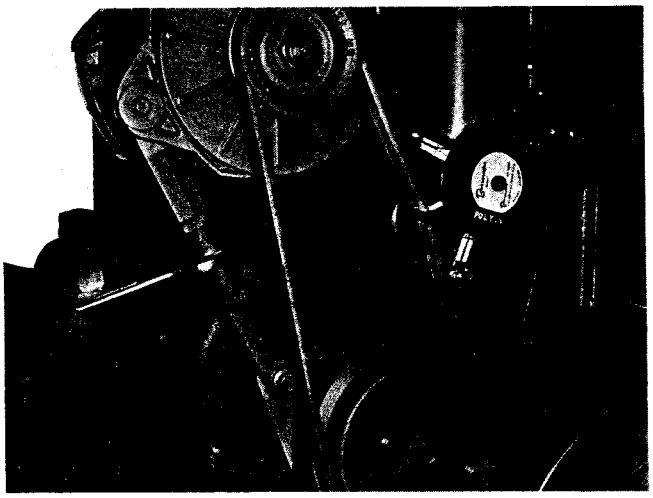


Fig. 2-3, (K114101). Checking belt tension with ST-1293

and/or adjust belts to tension as indicated in Table 2-1.

Table 2-1: Belt Tension (Pounds)

Belt Width Inches	Belt Gauge	*New Belt Tension + or —10	**Belt Tension After Run-in + or —10
Standard "V" Belt			
1/2	ST-968	140	100
	ST-1274	140	100
11/16	ST-1138	140	100
3/4	ST-1138	140	100
Poly-V			
6 Rib	ST-1293	150	130
Special Applications			
V-378, V-504, V-555			
2 Pulley (Fan-alternator drive)			
1/2	ST-968	90	50
	ST-1274	90	50
3 Pulley (crankshaft, water pump, fan drive)			
1/2	ST-968	130	90
	ST-1274	130	90
11/16	ST-1138	140	100
NT-855 (Water pump with idler)			
15/32	ST-968	130	80
	ST-1274	130	80

*New belts must be retensioned to values listed under "Belt tension after run-in".

**Used belts should be retensioned to values listed under "Belt tension after run-in".

Note: When using the "Krikit" gauge the correct belt tension reading for the belt tested must be read at the point where the **top** of the black indicator arm crosses the bottom numbered scale. Position gauge in the center of the belt between two pulleys. The flange at side of gauge should be flat against edge of belt.

Inline Engine Water Pump Belts (No Idler)

1. Eccentric water pump adjustment.
   a. Loosen water pump clamp ring to allow pump body to turn.
   b. Loosen pump body by pulling up on belts. A sharp jerk may be required.
   c. Insert bar in water pump body slots and rotate pump body counterclockwise to tighten belts.

Note: Do not adjust to final tension at this time.

   d. Snug clamp ring capscrew farthest from belts, on exhaust side to 5 ft-lbs [7 N • m].
   e. Snug two capscrews above and below the first one to 5 ft-lbs [7 N • m].
   f. Finish tightening by alternating from side to side in 5 ft-lbs [7 N • m] increments to a final torque of 12 to 15 ft-lbs [16 to 20 N • m].
   g. Check belt tension.

Final belt tension was not obtained by adjustment alone. The water pump body was pulled straight by snugging the capscrews in the order described, thus increasing belt tension to final value.

2. Adjustable (split) pulley water pumps, V-903 Engines only.
   a. Remove capscrews joining the sheave(s) of the pulley.

Note: Clean capscrew threads and holes in sheaves thoroughly to avoid capscrew breakage during reassembly.

   b. The outer half of the pulley is screwed onto the hub extension of the inner half. Some pulleys are provided with flats, and some with lugs for barring.
   c. Bar the engine over to roll the belt outward on the pulley as the outer half is turned in.
   d. Adjust belt(s) to tension indicated in Table 2-1.
   e. Turn outer sheave(s) in enough to align the capscrew holes.

f. Start capscrews and tighten alternately and evenly. Final tension is:

5/16-18 capscrew, 10 to 12 ft-lbs [14 to 16 N • m]
3/8-16 capscrew, 17 to 19 ft-lbs [23 to 26 N • m]

g. Bar engine over one or two revolutions to seat belt.

h. Recheck belt tension.

Inline Engine Water Pump Belts (With Idler)

1. Loosen capscrews and lockwashers or locknut securing idler pulley to bracket or water pump. Fig. 2-4.

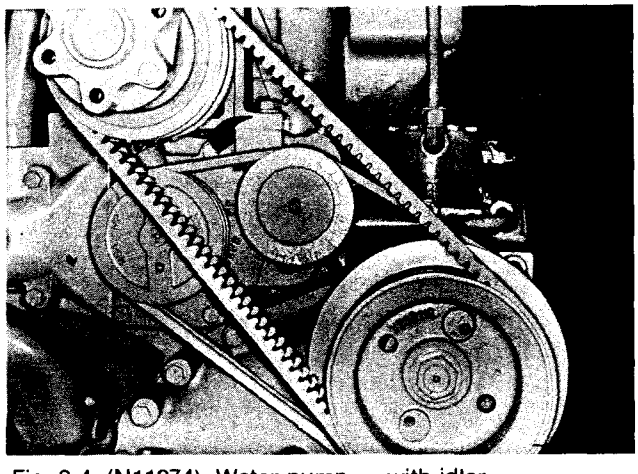


Fig. 2-4, (N11974). Water pump — with idler

2. Using a pry bar (NTA) or adjusting screw (FFC) adjust idler pulley until proper belt tension is indicated on gauge. See Table 2-1.
3. Secure idler pulley or bracket in position by tightening locknut or capscrews and lockwashers to 45 to 55 ft-lbs [61 to 75 N • m] torque.

Note: Self tensioning idler on V-1710 belt driven water pumps requires no adjustment or belt tension check.

Fan Drive Belts

1. Loosen large locking nut on fan hub shaft or capscrews securing fan hub shaft to mounting bracket. The fan hub will fall out of line when this is done.
2. Turn the adjusting screw to increase belt tension.
3. Tighten the locknut or capscrews until the fan hub is straight. Snug the nut to maintain hub in proper alignment with the fan hub bracket.

Caution: Do not adjust to full tension with the adjusting screw, this would result in overtightening.

4. Belt tension should read as indicated in Table 2-1 on applicable gauge.
5. Tighten NH/NT Engines locknut to 400 to 450 ft-lbs [542 to 610 N • m]; then back off 1/2 turn. Tighten the four 1/2 inch capscrews, Fig. 2-5, on NTC-350 FFC Engines to 75 to 85 ft-lbs [101 to 115 N • m].

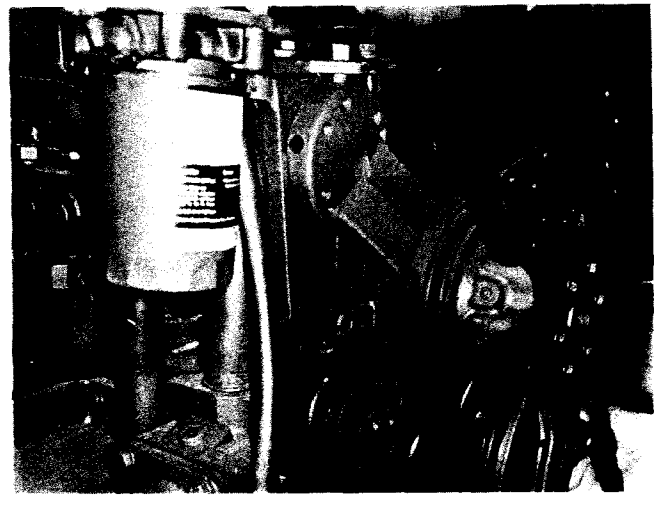


Fig. 2-5, (N12018). Fan hub installation —NTC-350 FFC

On V-903 Engines tighten capscrews to 75 ft-lbs [102 N • m] or single nut to 450 ft-lbs [610 N • m].

6. Recheck belt tension.
7. Back out adjusting screw one-half turn to prevent breakage.

Note: Self tensioning backside idler on KT/KTA-2300 and KTA-3067 belt driven fan requires no adjustment or belt tension check.

Generator/Alternator Belts

Belt tension should be as indicated in Table 2-1 when measured with the applicable gauge.

Belt Installation

If belts show wear or fraying, replace as follows:

1. Always shorten distance between pulley centers so belt can be installed without force. Never roll a belt over the pulley and never pry it on with a tool such as a screwdriver. Either of these methods will damage belts and cause early failure.
2. Always replace belts in complete sets. Belts riding

depth should not vary over 1/16 in [1.6 mm] on matched belt sets.

3. Pulley misalignment must not exceed 1/16 in [1.6 mm] for each ft [0.3 m] of distance between pulley centers.
4. Belts should not bottom on pulley grooves nor should they protrude over 3/32 in [2.4 mm] above top edge of groove.
5. Do not allow belts to rub any adjacent parts.
6. Adjust belts to proper tension.

Readjusting New Belts

All new belts will loosen after running for 5 minutes and must be readjusted to "belt tension after run-in". Ref. Table 2-1.

Check Oil Bath Cleaner Oil Level

Daily check oil level, Fig. 2-6, in oil bath air cleaner to be sure oil level in cup is at indicated mark. Refill as required.

***Cummins Engine Company, Inc. recommends the use of dry type air cleaners.**

Check for Damage

Visually check fuel system, etc., including AFC fuel pump, for misadjustment or tampering; check all connections for leaks or damage. Check engine for damage; correct as necessary.

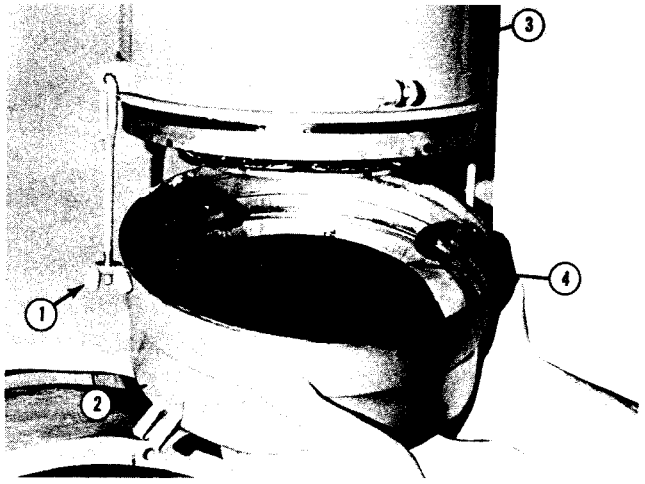


Fig. 2-6, (N11001). Checking oil level in air cleaner

"A" Maintenance Checks—Weekly

Repeat Daily Checks

Check Air Cleaner

Clean Pre-Cleaner and Dust Pan

Under extremely dirty conditions an air pre-cleaner may be used. Clean pre-cleaner jar and dry-type air cleaner dust pans daily or more often, as necessary, depending on operating conditions.

Check Inlet Air Restriction

Mechanical Indicator

A mechanical restriction indicator is available to indicate excessive air restriction through a dry-type air cleaner. This instrument can be mounted in air cleaner outlet or on vehicle instrument panel. The red flag (1, Fig. 2-7) in window gradually rises as cartridge loads with dirt. After changing or replacing cartridge, reset indicator by pushing reset button (2).

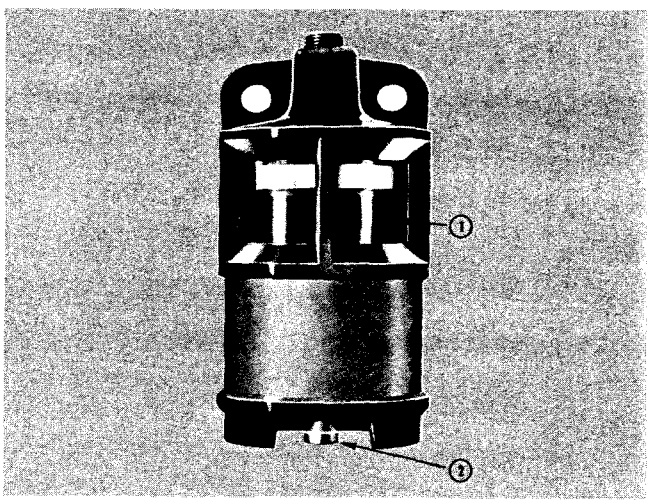
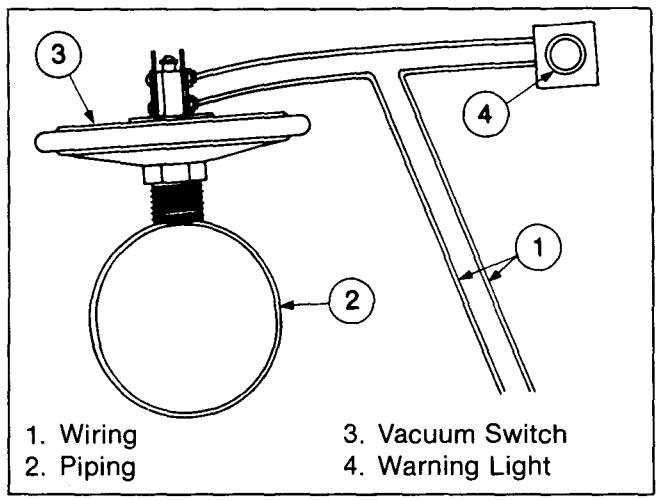


Fig. 2-7, (CGS-20). Air inlet restriction indicator

Note: Never remove felt washer from indicator, it is necessary to absorb moisture.

Vacuum Indicator

Vacuum switches, Fig. 2-8, are available which actuate a warning light on the instrument panel when air restriction becomes excessive.



1. Wiring
2. Piping
3. Vacuum Switch
4. Warning Light

Fig. 2-8, (N21905). Vacuum switch to check air inlet

1. Air restriction on turbocharged engines must not exceed 25 inches [635 mm] of water or 1.8 inches [46 mm] of mercury under full power conditions.
2. Naturally aspirated engine air restriction must not exceed 20 inches [508 mm] of water or 1.5 inches [38 mm] of mercury at air intake manifold at rated speed.

Clean or Replace Air Cleaner Elements

The paper element in a dry-type air cleaner, Fig's. 2-9, 2-10, 2-11 and 2-12, may be cleaned several times by using air to blow off dirt or by washing with nonsudsing household detergent and water at 120 to 140° F [49 to 60° C], then drying with compressed air, approximately 30 psi [306 kPa]. Do not hold air jet too close to paper element.

Elements that have been cleaned several times will finally clog and air flow to engine will be restricted. After cleaning, check restriction as previously described and replace element if necessary.

Caution: Holes, loose end seals, dented sealing surfaces and other forms of damage render cleaner inoperative and require immediate element replacement.

To change element:

1. Loosen wing nut (1, Fig. 2-9) securing bottom cover

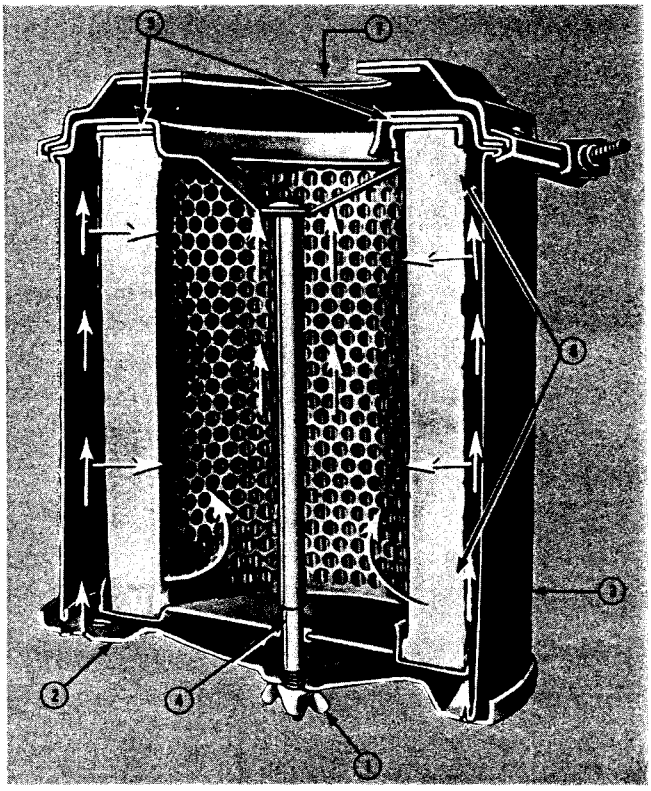


Fig. 2-9, (N11003). Air cleaner — dry type

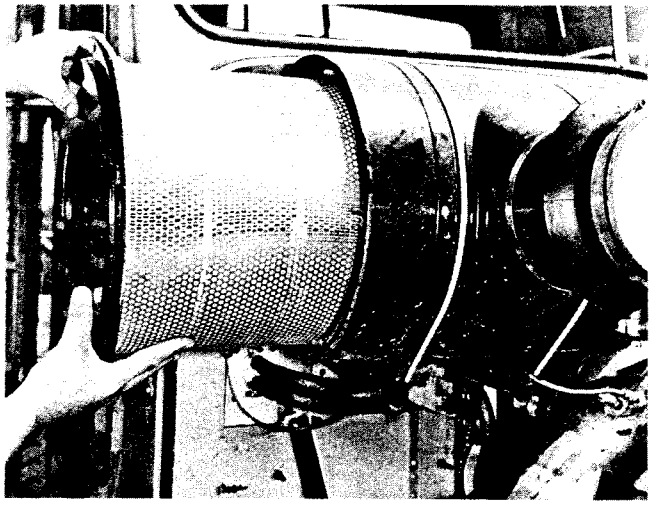


Fig. 2-10, (K11913). Changing air cleaner element

(2) to cleaner housing (3). Remove cover.

2. Pull element (6) down from center bolt (4).

Caution: Pull cover and element straight out when removing from housing, Fig. 2-10, to avoid damage to element.

3. Remove gasket (5) from outlet end (7) of housing.

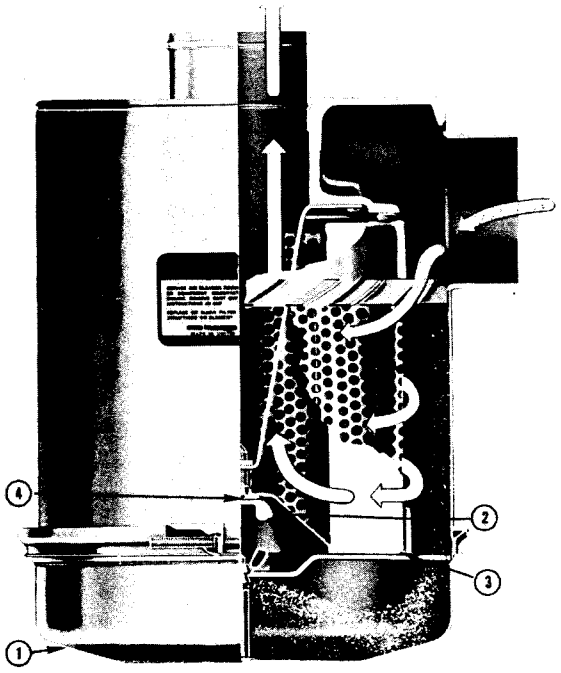


Fig. 2-11, (V10005). Air cleaner — heavy duty

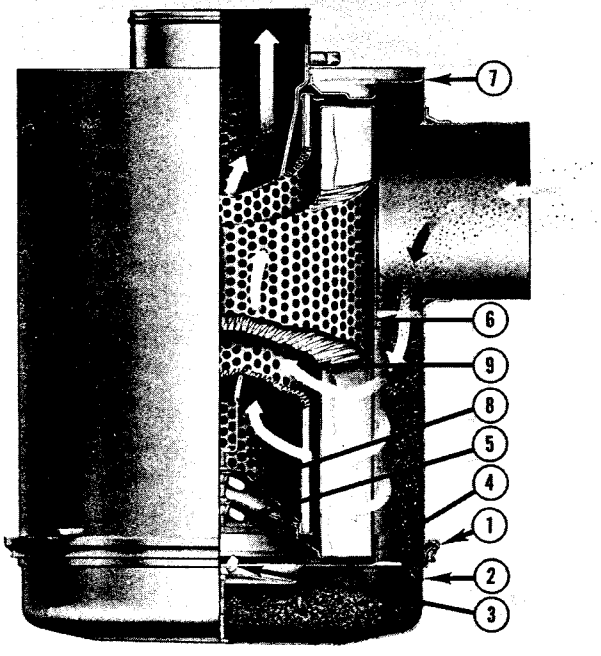


Fig. 2-12, (N11030). Air cleaner — heavy duty (dual element)

When installing the element, make sure it seats on the gasket at the air cleaner outlet end.

Heavy Duty Dry-Type Air Cleaners

Heavy duty air cleaners (single and dual types) combine centrifugal cleaning with element filtering, Fig's. 2-11 and 2-12, before air enters engines.

Before disassembly, wipe dirt from cover and upper portion of air cleaner. To clean single or dual types:

1. Loosen wing bolt, remove band securing dust pan (1, Fig. 2-11), (2, Fig. 2-12).
2. Loosen wing nut (2, Fig. 2-11 and 3, Fig. 2-12), remove dust shield (3, Fig. 2-11), (4, Fig. 2-12), from dust pan (1, Fig. 2-11), (2, Fig. 2-12), clean dust pan and shield.
3. Remove wing nut (2, Fig. 2-11), (5, Fig. 2-12) securing air cleaner primary element (6, Fig. 2-12) in air cleaner housing, inspect rubber sealing washer on wing nut (4, Fig. 2-11), (5, Fig. 2-12).
4. Blow out element from clean air side with compressed air not exceeding 30 psi [207 kPa].
5. Wash element with nonsudsing household detergent and water, 120 to 140° F [49 to 60° C]. Dry with compressed air, 30 psi [207 kPa].
6. Inspect element after cleaning.
7. Install new or cleaned primary element.
8. Be sure gasket washer is in place under wing nut before tightening.
9. Reassemble dust shield and dust pan, position to air cleaner housing and secure with band.
10. On dual element type Cyclopac cleaner:
    a. Check air restriction indicator, if air restriction is excessive, disassemble air cleaner, remove wing nut (8, Fig. 2-12), and replace safety element (9).
    b. Reassemble air cleaner as described in "Steps 8 and 9" above.

Cartridge Type Air Cleaner Element

1. Loosen wing nuts (4, Fig. 2-13 or 2-14) on air cleaner housing (5) to remove pre-cleaner panel with dust bin (1). To remove pre-cleaner panel (2) equipped with exhaust aspirator loosen "U" bolt clamp securing pre-cleaner to aspirator tubing.

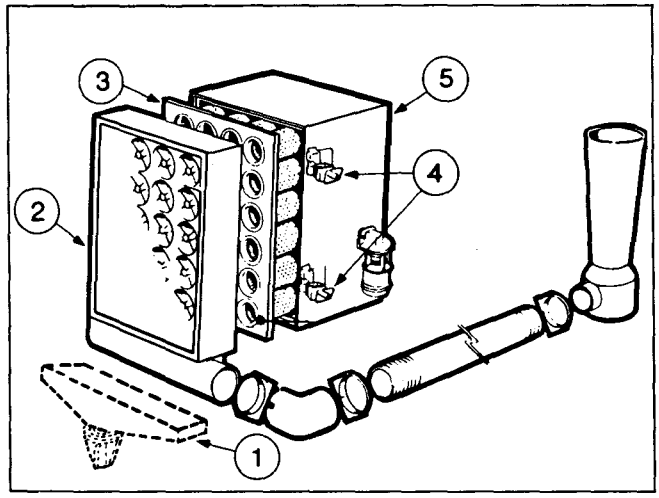


Fig. 2-13, (N21026). Air cleaner — cartridge type (two stage)

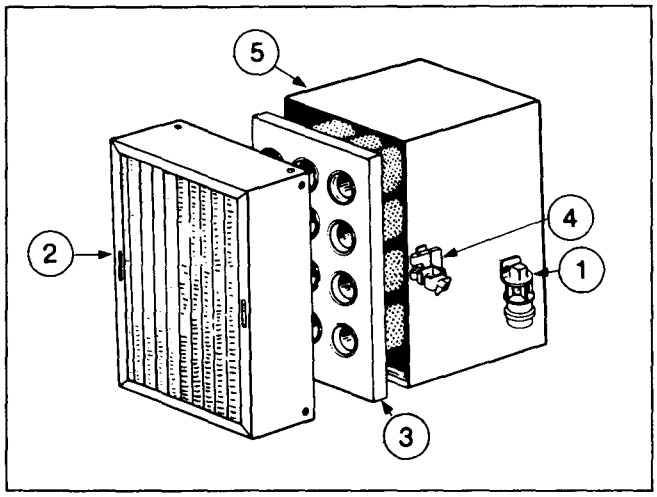


Fig. 2-14, (V11009). Air cleaner — cartridge type (single stage)

2. Remove dirty Pamic cartridge (3), by inserting fingers in cartridge opening (loosen all four corners of cartridge, one at a time) and pulling straight out.

With larger cartridge, it may be necessary to break seal along edges of cartridge. After seal has been broken, pull the cartridge straight out and slightly up so cartridge will clear sealing frame and edges of air cleaner housing.

Cleaning and Inspection

1. Clean pre-cleaner openings (2) of all soot, oil film and any other objects that may have become lodged in openings. Remove any dust or dirt in lower portion of pre-cleaner and aspirator tubing. Inspect inside of air cleaner housing for foreign material.
2. Inspect dirty cartridge for soot or oil. If there is soot

inside Pamic tubes, check for leaks in engine exhaust system, exhaust "blow-back" into air intake and exhaust from other equipment. If cartridge appears "oily", check for fumes escaping from crankcase breather. Excessive oil mist shortens life of any dry-type cartridge. Troubleshooting at this point can appreciably lengthen new cartridge life.

3. It is not recommended to clean and reuse cartridge. When returned to service, life expectancy of a paper cartridge will be only a fraction of original service life.
4. Inspect clamps and flexible hose or tubing to be sure all fittings are air tight on cleaners with exhaust aspirators.
5. The pre-cleaner dust bin is self-cleaning.

Assembly

1. Inspect new filter cartridge for shipping damage before installing.
2. To install a new cartridge, hold cartridge (3, Fig. 2-13 and 2-14) in same manner as when removing from housing. Insert clean cartridge into housing; avoid hitting cartridge tubes against sealing flange on edges of air cleaner housing.
3. The cleaner requires no separate gaskets for seals; therefore, care must be taken inserting cartridge to insure a proper seat within cleaner housing. Firmly press all edges and corners of cartridge with fingers to effect a positive air seal against sealing flange of housing. Under no circumstances should cartridge be pounded or pressed in center to effect a seal.
4. Replace pre-cleaner panel (2) and tighten wing nuts (4) by hand, for final tightness turn 1-1/2 to 2 turns with a small adjustable wrench. Do not overtighten. On pre-cleaner with exhaust aspirator, assemble aspirator tube to pre-cleaner panel and tighten "U" bolt.
5. Care should be taken to keep cleaner face unobstructed.

Change Oil Bath Air Cleaner Oil

Before dirt build-up reaches 1/2 inch [12.7 mm], remove oil cup from cleaner. Discard oil and wash cup in cleaning solvent or fuel oil.

Note: During wet weather and in winter months, changing of oil is equally as important as during dusty weather since the air cleaner inlet may be located in an air stream which carries moisture into the cleaner.

Fill oil cup to level indicated by bead on side with clean, fresh oil of the same grade as that in crankcase and assemble to cleaner. In extremely cold weather a lighter grade may be necessary. A straight mineral, non-foaming detergent, or non-foaming additive oil may be used in oil bath air cleaners.

Caution: Never use dirty or used oil.

Drain Air Tanks

In cold weather, condensed moisture in air tanks and lines may freeze and make controls useless.

Drain air tanks to keep all water out of the compressed air system.

Drain Sediment from Fuel Tanks

Loosen fuel tank drain cock or plug, if used, and drain approximately 1 cup of fuel to remove water and sediment. Close drain cock or plug.

Fuel/Water Filter Separator

If more moisture than usual is present when checking fuel tanks, it may be advisable to install a water separator.

Contact the nearest Cummins Dealer for a Fleetguard water separator that meets requirements.

Drain plugs are located in bottom of some fuel filter cases and in sump of some fuel supply tanks. More condensation of water vapor occurs in a partially filled fuel tank than in a full one. Therefore, fuel supply tanks should be kept as nearly full as possible. Warm returning fuel from injectors heats fuel in the supply tank. If fuel level is low in cold weather, the fact that the upper portion of the tank is not being heated by returning fuel tends to increase condensation. In warm weather both supply tank and fuel are warm. In the night, however, cool air lowers temperature of the tank much more rapidly than the temperature of the fuel. Again this tends to increase condensation.

"B" Maintenance Checks

At each "B" Maintenance Check, perform all "A" Checks in addition to the following.

Change Engine Oil

Factors to be checked and limits for oil analysis are listed below. Oil change at "B" Check, as shown in maintenance chart on Page 2-2, is for average conditions.

1. Bring engine to operating temperature, shut down engine, remove drain plug from bottom of oil pan, and drain oil.
2. Install drain plug in oil pan. On 855, V-903, KT(A)-1150, KT(A)-2300 and KTA-3067 Engines torque to 60 to 70 ft-lbs [81 to 95 N • m]. On V-378, V-504 and V-555 Engines torque to 35 to 40 ft-lbs [47 to 54 N • m]. On V-1710 Engines torque to 45 to 55 ft-lbs [61 to 75 N • m].
3. Fill crankcase to "H" (high level) mark on dipstick.
4. Start engine and visually check for oil leaks.
5. Shut down engine; allow 15 minutes for oil to drain back into pan; recheck oil level with dipstick. Add oil, as required.

Note: Use lubrication oil meeting specifications listed in Section 3, and genuine Cummins filters on equipment.

Lubricating Oil Change Intervals

1. The recommended oil change interval is determined by the "Chart Method" based on fuel oil consumed and lubricating oil added. See "Chart Method" following.
2. An alternate to the "Chart Method" is 250 hours or 6 months.
3. A second alternate method of determining oil change interval may be established through the use of oil analysis. Refer to "Lubricating Oil Analysis".

Chart Method

Advancement in lubrication technology has made it possible for users of Cummins engines to successfully extend oil change intervals, thus reducing maintenance costs.

Note: At oil change, change full-flow filter, by-pass filter (if used) and fuel oil filter.

Lubricating oil change intervals depends on the following variables:

1. Fuel consumption per hour.
2. Oil consumption per hour.
3. Filtration systems.
4. Lubricating system capacity.

The following graphs are to be used to determine the proper oil change interval for engines.

Total lubricating system capacity (in gallons) can be determined by adding the oil pan (high level), full-flow filter(s) and by-pass filter(s) capacities. Total lubricating capacities must be rounded to the nearest gallon. See example following.

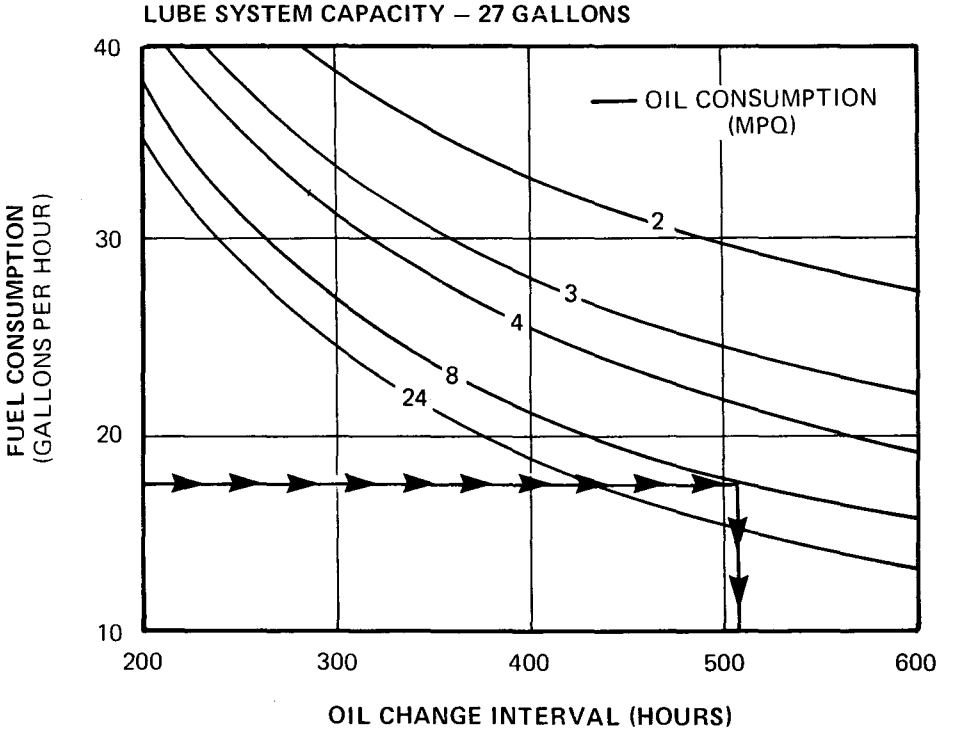
Note: Cummins Engine Company, Inc. **does not** recommend exceeding 600 hour oil change intervals. Therefore, curves are limited to 600 hours and should not be extended.

VT-1710 Off-Highway Engine

Oil pan capacity	18.00 gal.
Full-flow filter (3)	2.79 gal.
By-pass filter (2)	5.82 gal.
Total system capacity	26.61 gal. — 27 gallons

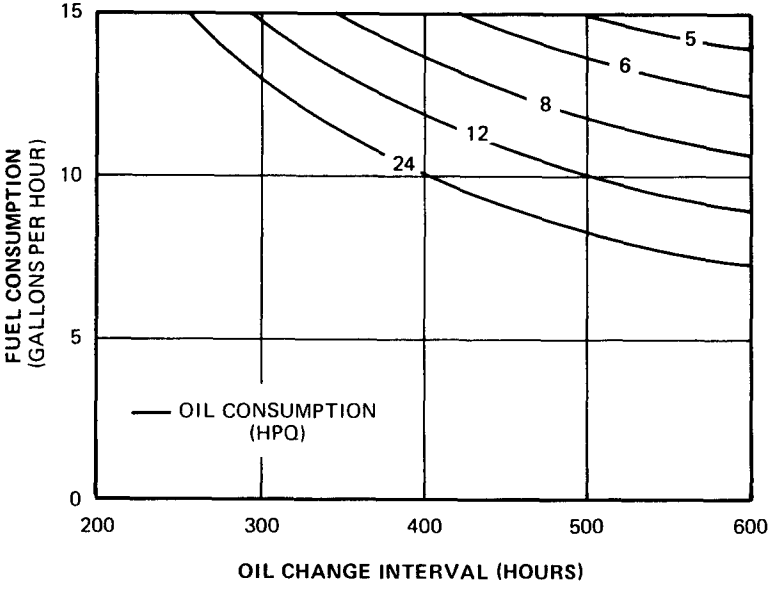
Example:

VT-1710 Off-Highway Engine With 750 By-Pass Filter
Lubricating System Capacity – 27 Gallons
Fuel Consumption: 17.5 Gallons/Hour
Oil Consumption: 8 Hours Per Quart
Recommended Oil Change Interval: 505 Hours

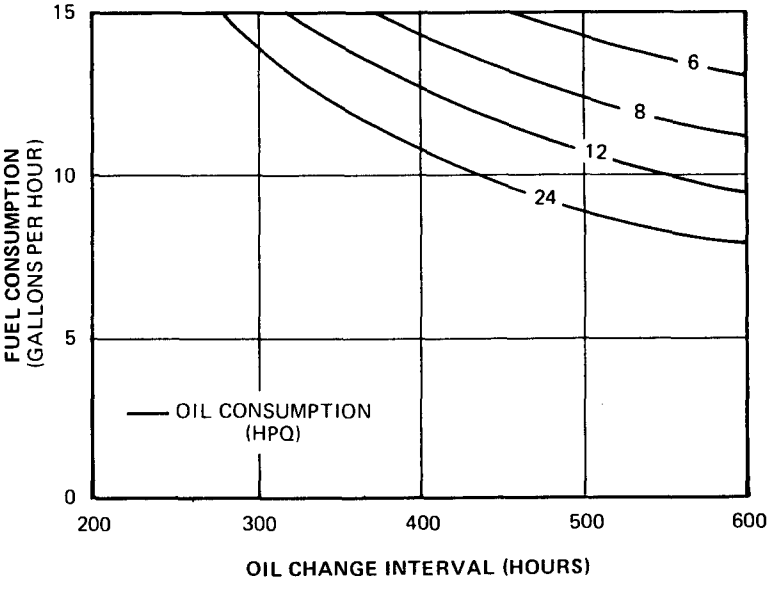


OFF HIGHWAY – NATURALLY ASPIRATED WITH BY-PASS FILTER

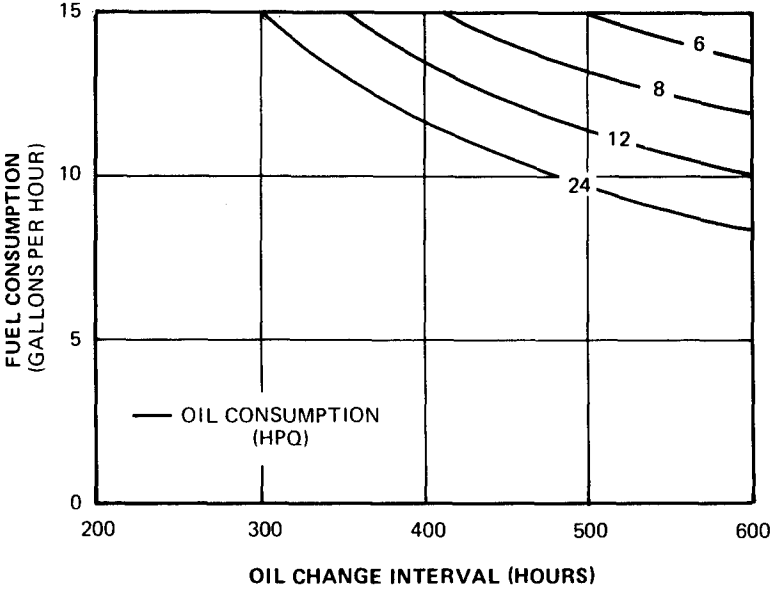
LUBE SYSTEM CAPACITY – 10 GALLONS



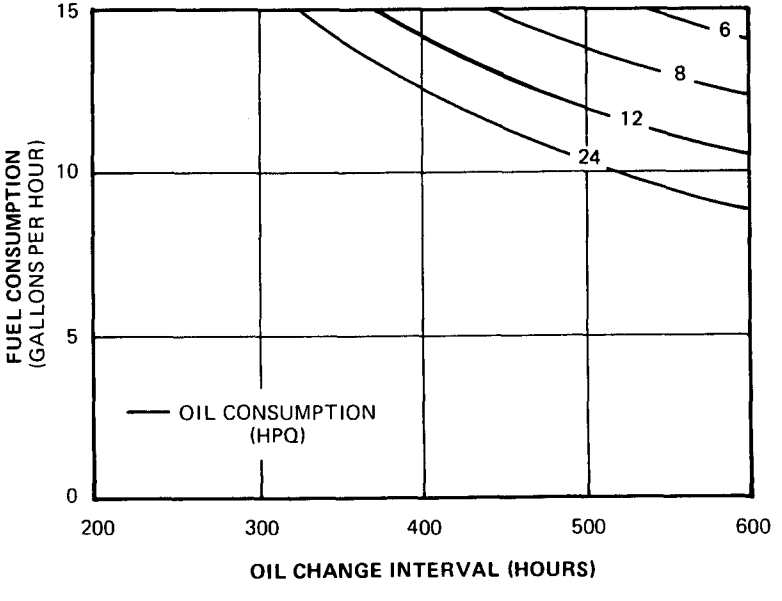
LUBE SYSTEM CAPACITY – 11 GALLONS



LUBE SYSTEM CAPACITY – 12 GALLONS

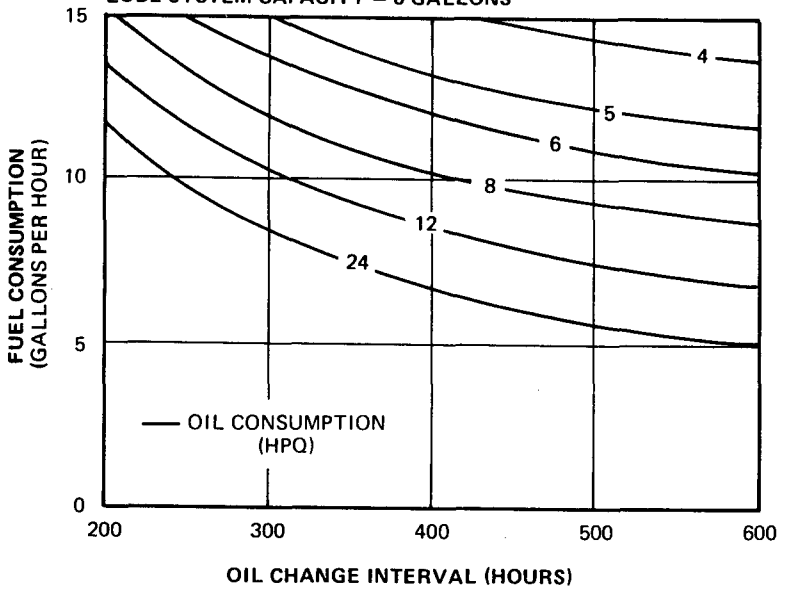


LUBE SYSTEM CAPACITY – 13 GALLONS

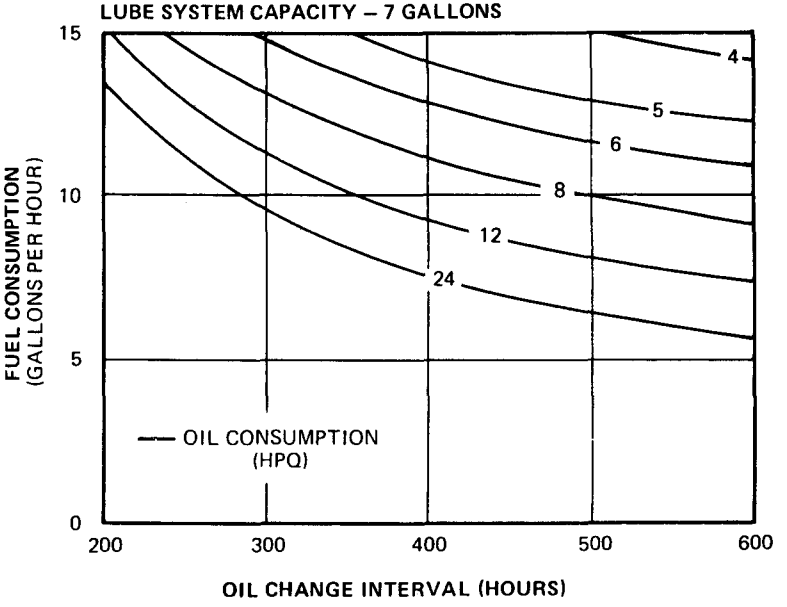


OFF HIGHWAY – NATURALLY ASPIRATED WITH BY-PASS FILTER

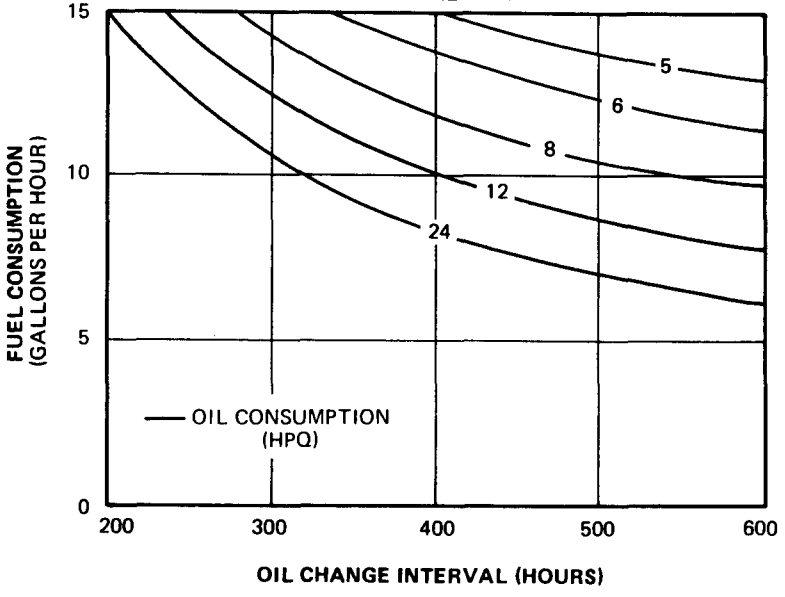
LUBE SYSTEM CAPACITY – 6 GALLONS



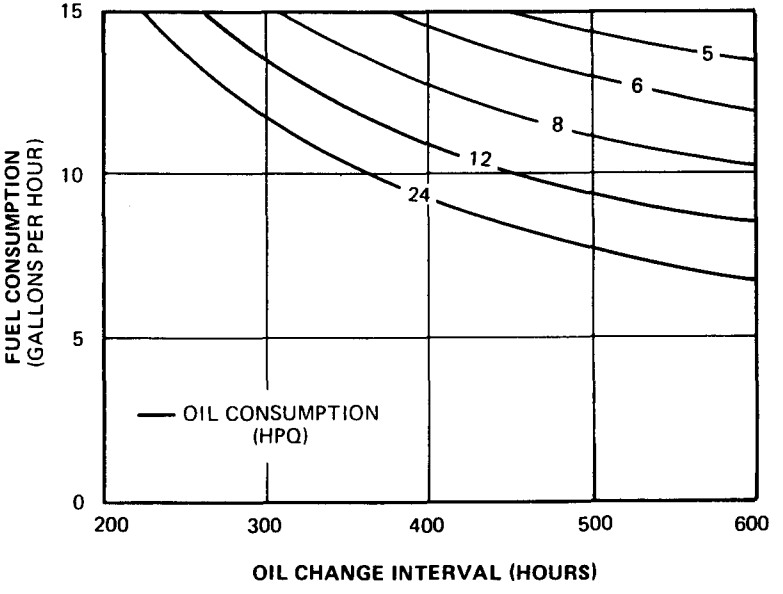
LUBE SYSTEM CAPACITY – 7 GALLONS



LUBE SYSTEM CAPACITY – 8 GALLONS

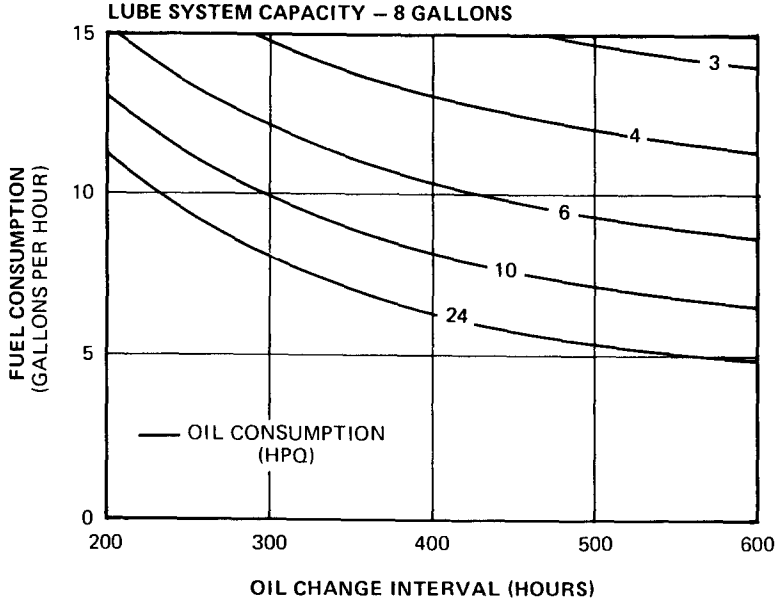


LUBE SYSTEM CAPACITY – 9 GALLONS

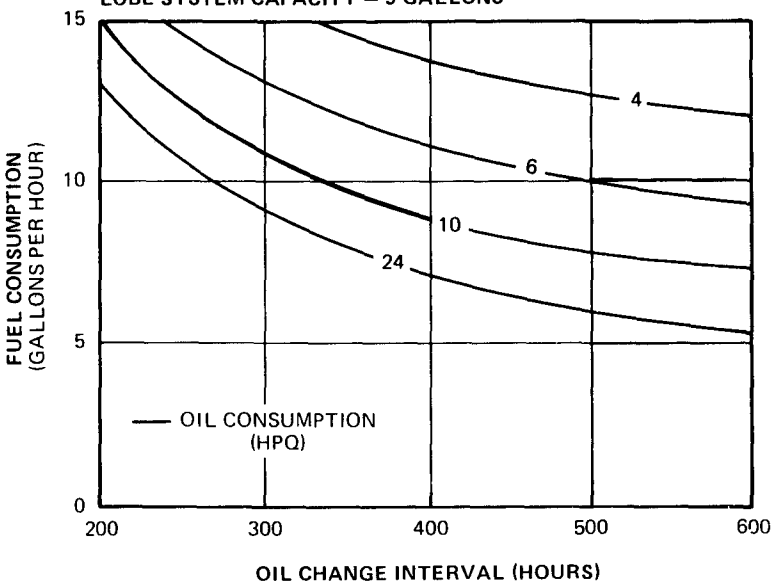


OFF HIGHWAY – TURBOCHARGED WITH BY-PASS FILTER

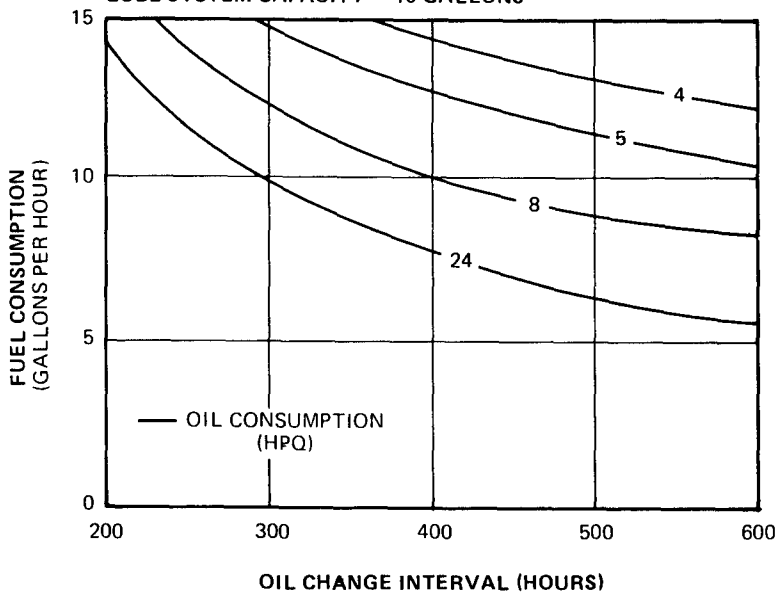
LUBE SYSTEM CAPACITY – 8 GALLONS



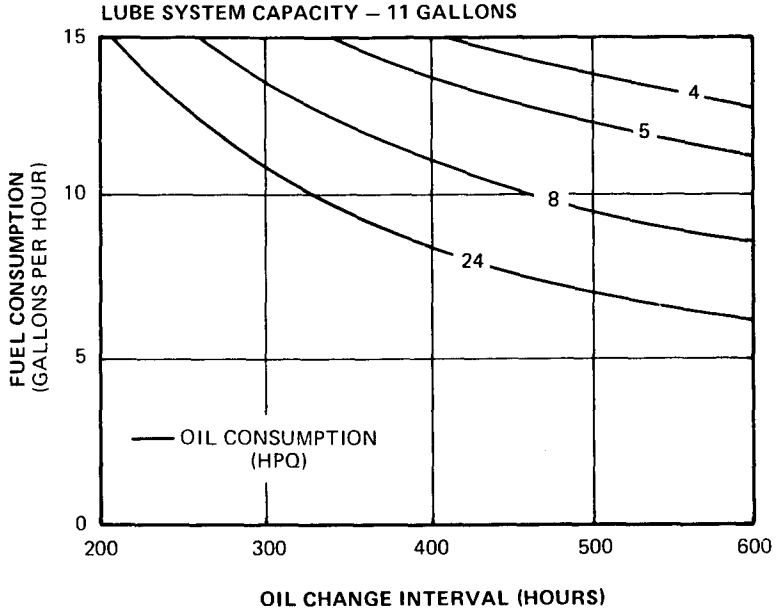
LUBE SYSTEM CAPACITY – 9 GALLONS



LUBE SYSTEM CAPACITY – 10 GALLONS

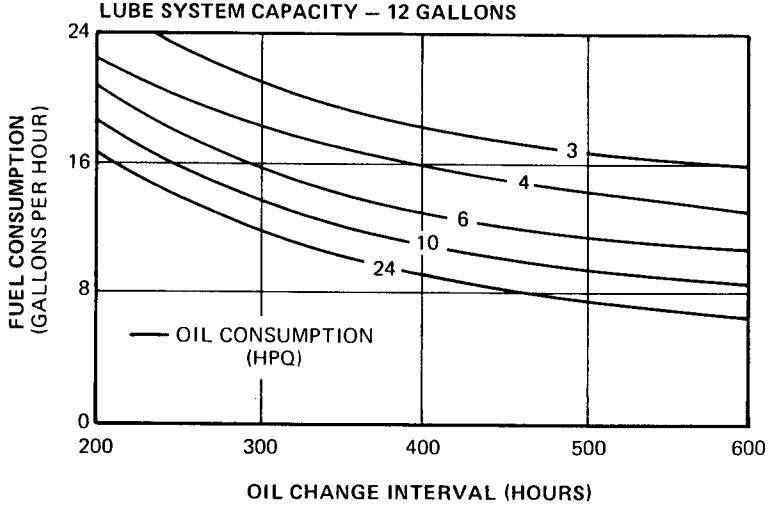


LUBE SYSTEM CAPACITY – 11 GALLONS

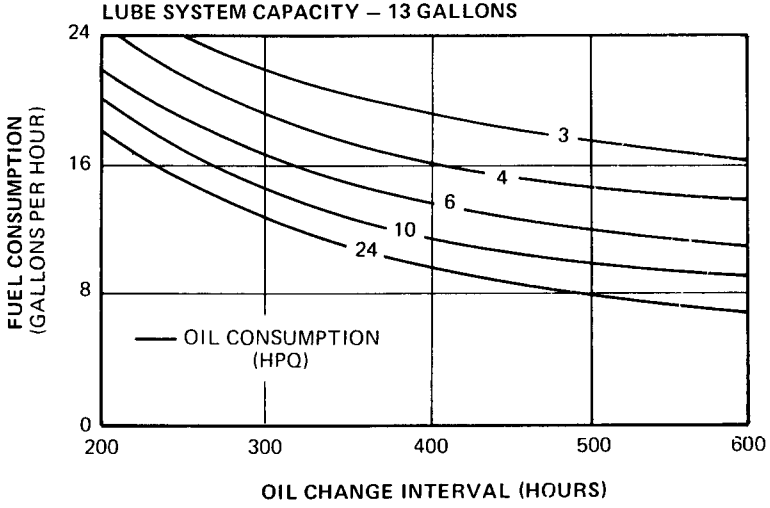


OFF HIGHWAY – TURBOCHARGED WITH BY-PASS FILTER

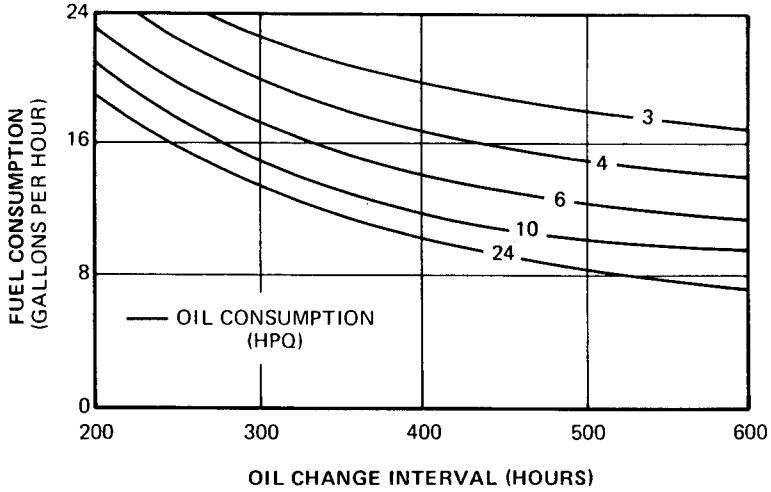
LUBE SYSTEM CAPACITY – 12 GALLONS



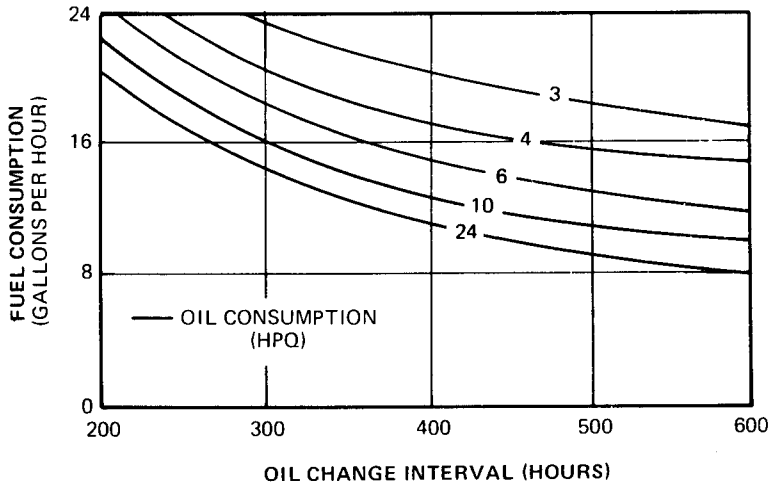
LUBE SYSTEM CAPACITY – 13 GALLONS



LUBE SYSTEM CAPACITY – 14 GALLONS

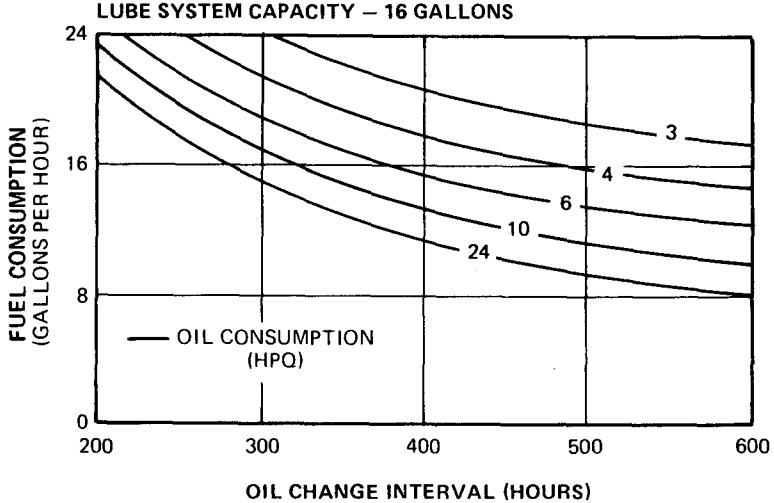


LUBE SYSTEM CAPACITY – 15 GALLONS

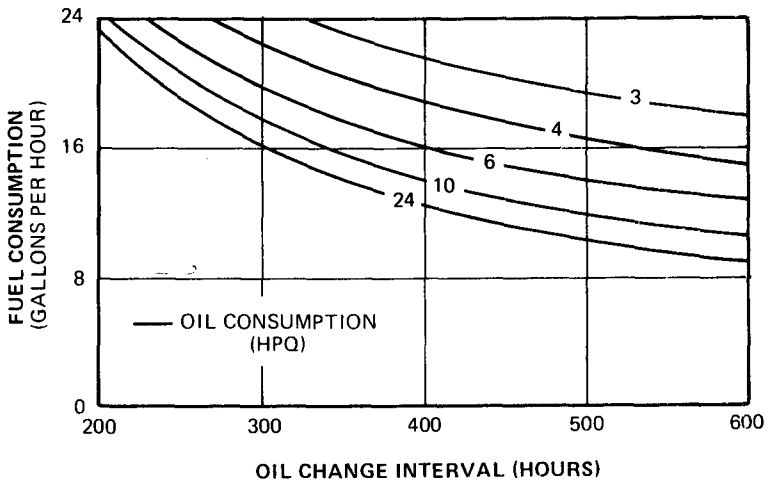


OFF HIGHWAY – TURBOCHARGED WITH BY-PASS FILTER

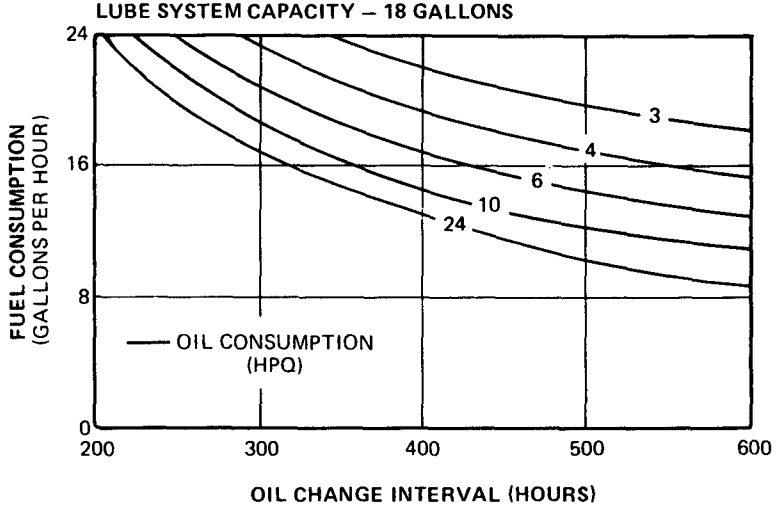
LUBE SYSTEM CAPACITY – 16 GALLONS



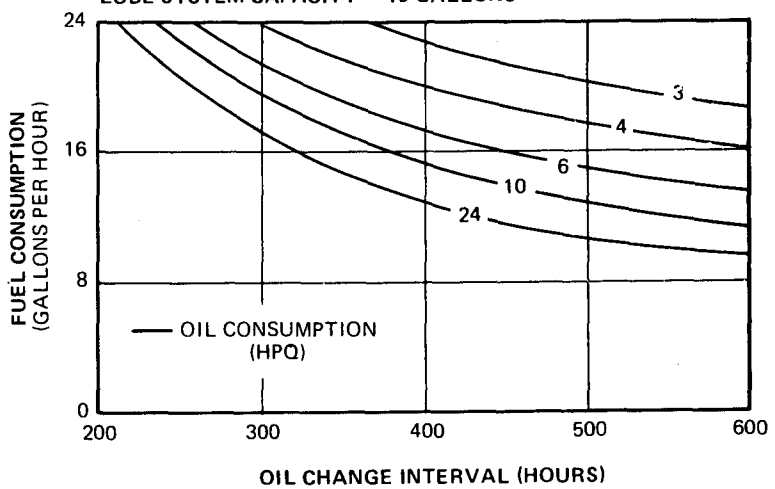
LUBE SYSTEM CAPACITY – 17 GALLONS



LUBE SYSTEM CAPACITY – 18 GALLONS

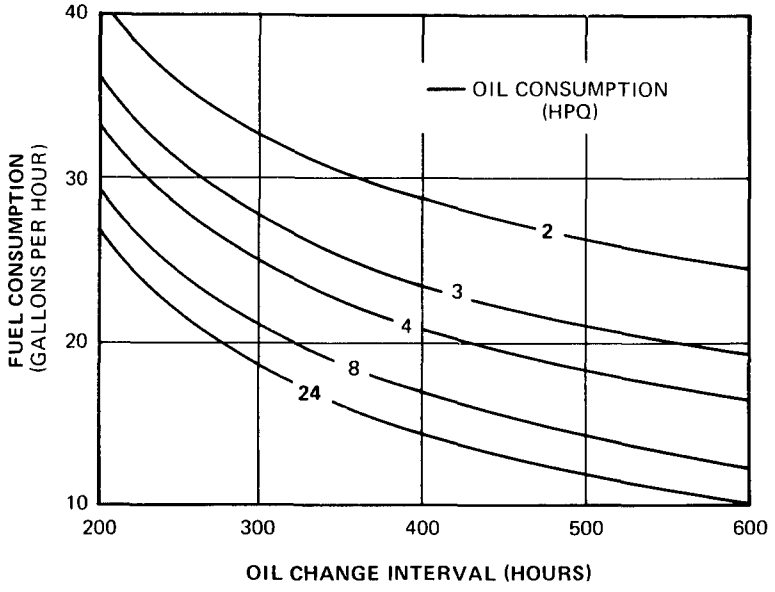


LUBE SYSTEM CAPACITY – 19 GALLONS

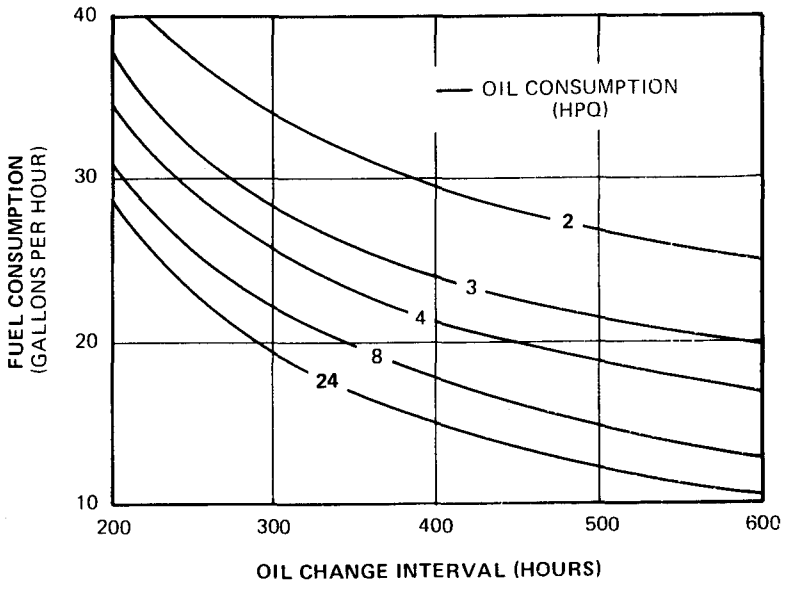


OFF HIGHWAY – TURBOCHARGED WITH BY-PASS FILTER

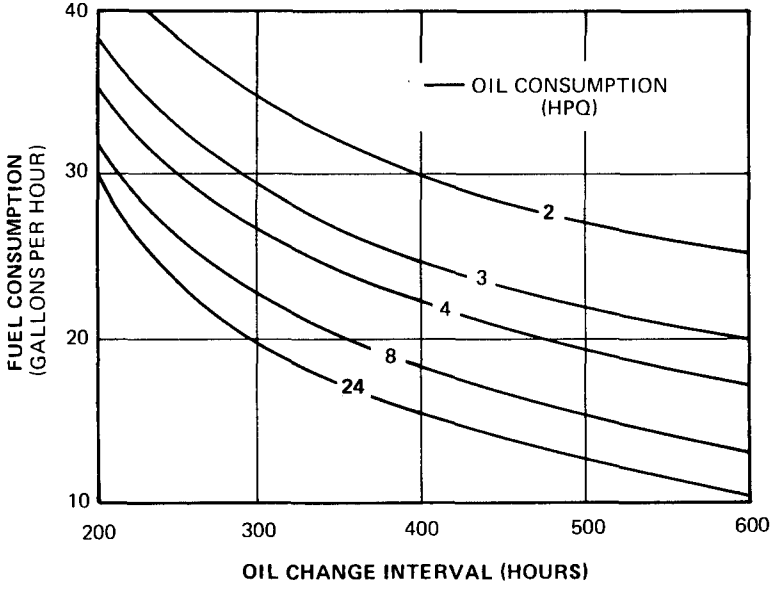
LUBE SYSTEM CAPACITY – 20 GALLONS



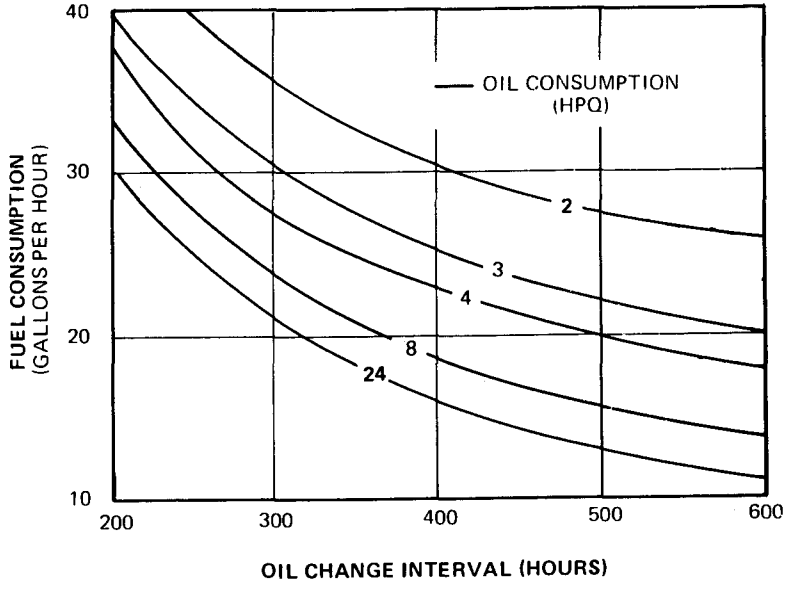
LUBE SYSTEM CAPACITY – 21 GALLONS



LUBE SYSTEM CAPACITY – 22 GALLONS

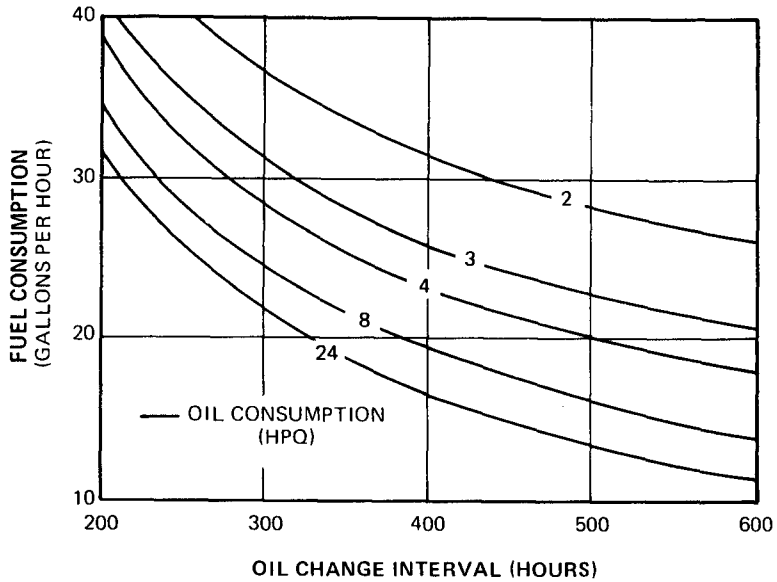


LUBE SYSTEM CAPACITY – 23 GALLONS

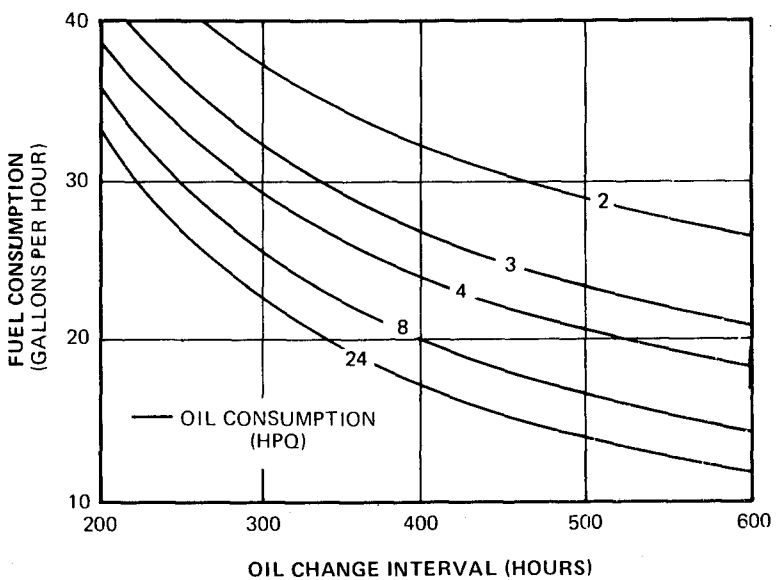


OFF HIGHWAY – TURBOCHARGED WITH BY-PASS FILTER

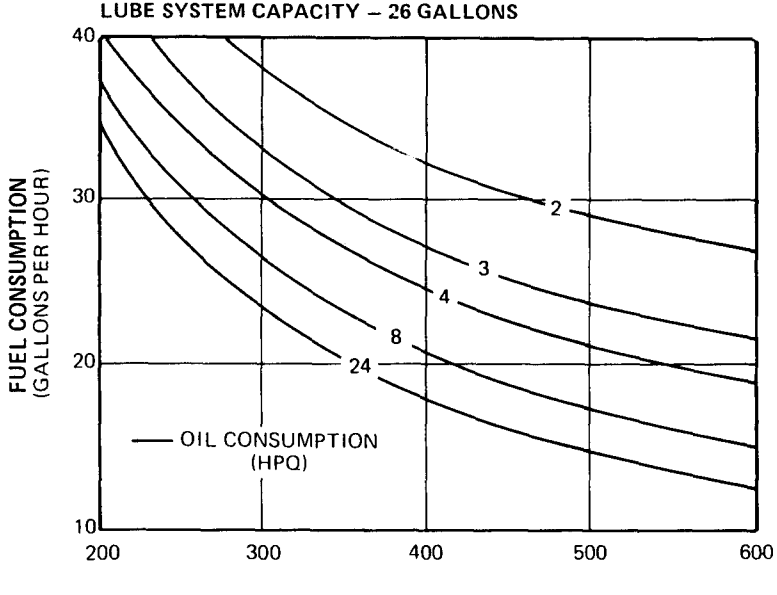
LUBE SYSTEM CAPACITY – 24 GALLONS



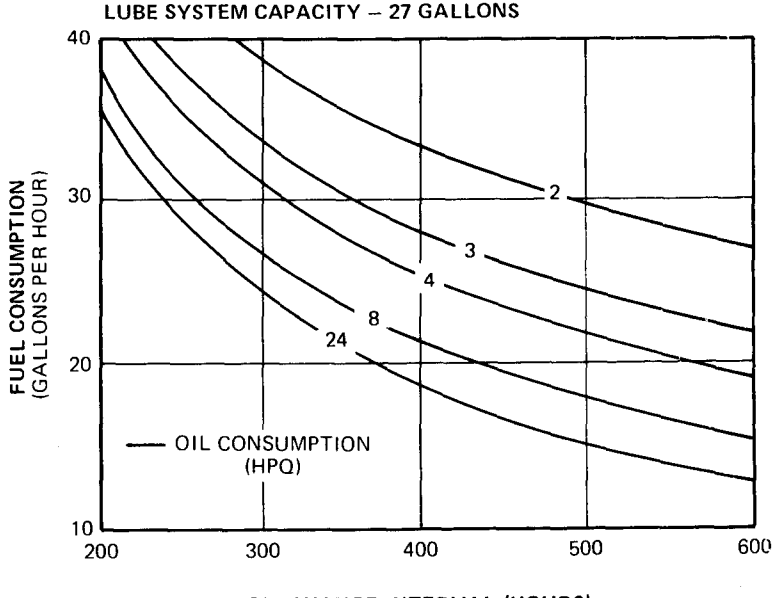
LUBE SYSTEM CAPACITY – 25 GALLONS



LUBE SYSTEM CAPACITY – 26 GALLONS

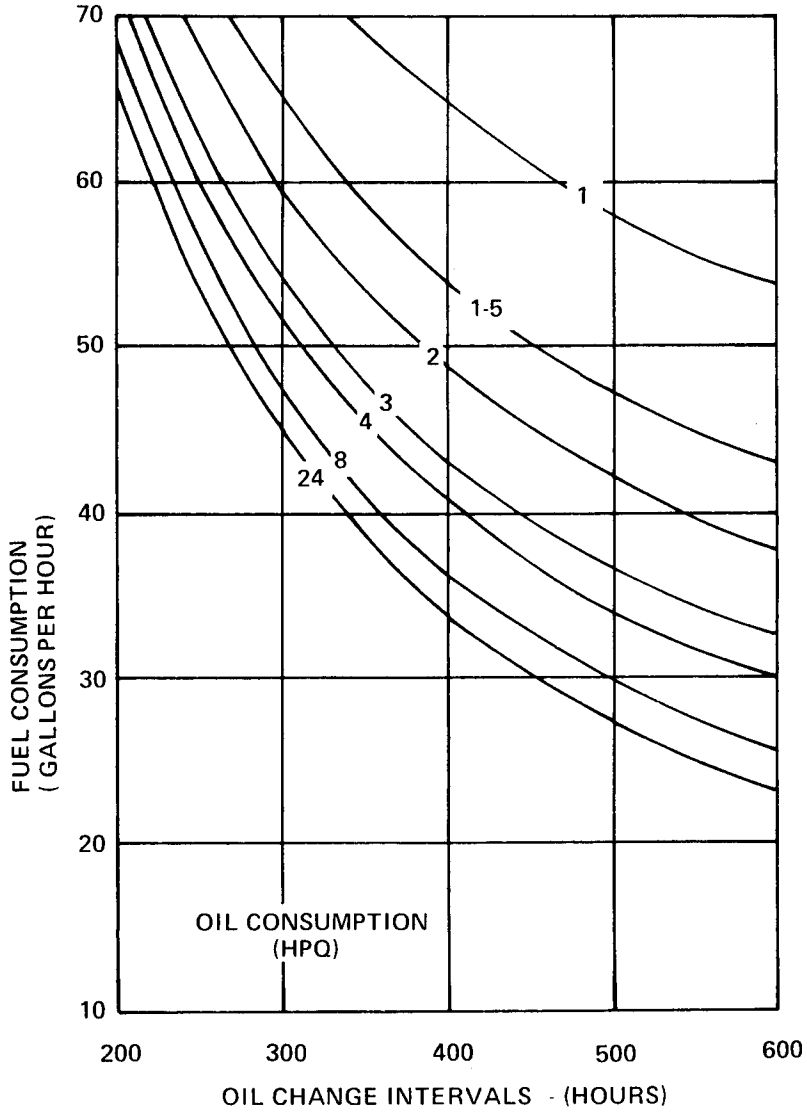


LUBE SYSTEM CAPACITY – 27 GALLONS



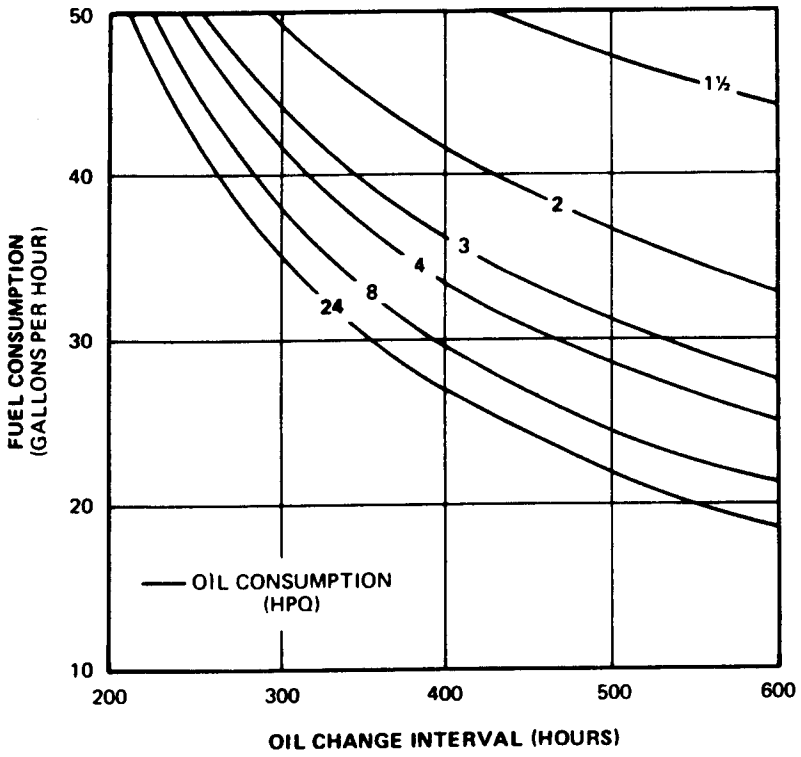
OFF HIGHWAY - TURBOCHARGED WITH BYPASS FILTER

LUBE SYSTEM CAPACITY - 51 GALLONS



OFF HIGHWAY – TURBOCHARGED WITH BY-PASS FILTER

LUBE SYSTEM CAPACITY – 40 GALLONS



Example:

VT-1710 Off-Highway Engine With 750 By-Pass Filter
Lubricating System Capacity — 27 Gallons
Fuel Consumption: 17.5 Gallons/Hour
Oil Consumption: 8 Hours Per Quart
Recommended Oil Change Interval: 505 Hours

Lubrication Oil Analysis

An alternate method for determining when to change lubricating oil is by oil analysis, using laboratory tests. A new series of tests should be run if filters, oil brands or grades are changed.

In the beginning, tests should be made each 100 gallons of fuel consumed (after the first 400 gallons), or 20 hours (after the first 100 hours) until the analysis indicates the first oil change is necessary.

Analysis Test for Lubricating Oil

Check oil properties in the following list during analysis. These methods are fully described in the American Society for Testing Materials Handbook.

Oil Property	Test Number
Viscosity at 100° F and 210° F	ASTM-D445
Sediment	ASTM-D893
Water	ASTM-D95
Acid and Base Number	ASTM-D664

General Limits for Oil Change

1. Minimum Viscosity (dilution limit): Minus one SAE grade from oil being tested or point equal to a minimum containing five percent by volume on fuel oil.
2. Maximum Viscosity: Plus one SAE grade from oil being tested, or ten percent increase at 210° F [99° C] or 25 percent increase at 100° F [38° C].
3. Sediment Content: Normal pentane insoluble 1.0 to 1.5 percent. Benzine insoluble 0.75 to 1.0 percent.
4. Acid Number: Total number 3.5 maximum.
5. Water Content: 0.2 percent maximum.
6. Additive Reduction: 25 percent maximum.

Caution: If the above tests indicate presence of any metal particles, or if found in filters, the source should be determined and corrective action taken before a failure results.

Change Spin-On Lubricating Oil Filter Elements

1. Unscrew combination case and elements, Fig. 2-15, discard elements.

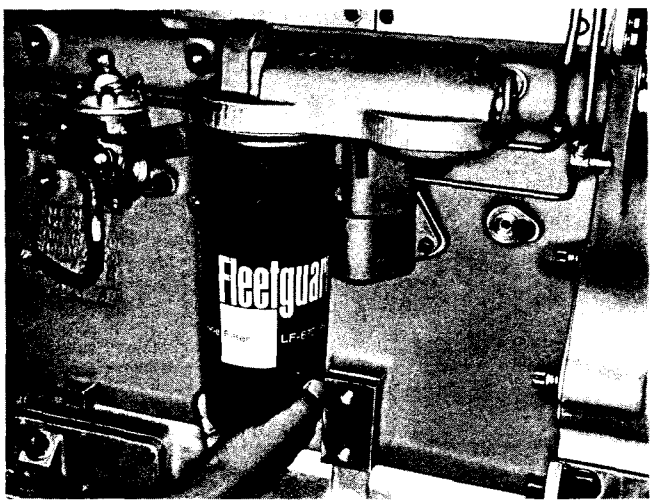


Fig. 2-15, (K11951). Removing "spin-on" lubricating oil filter — KT(A)-1150 Engine

Note: At each filter change check torque of adapter mounting capscrew; it should be 25 to 35 ft-lbs [34 to 47 N • m]. If the capscrew is not within torque range, the adapter may rotate when spin-on filter is removed. Replace adapter to filter head gaskets at each "C" maintenance check.

2. Fill elements with lubricating oil.
3. Position element to filter head, Fig. 2-16. Tighten by

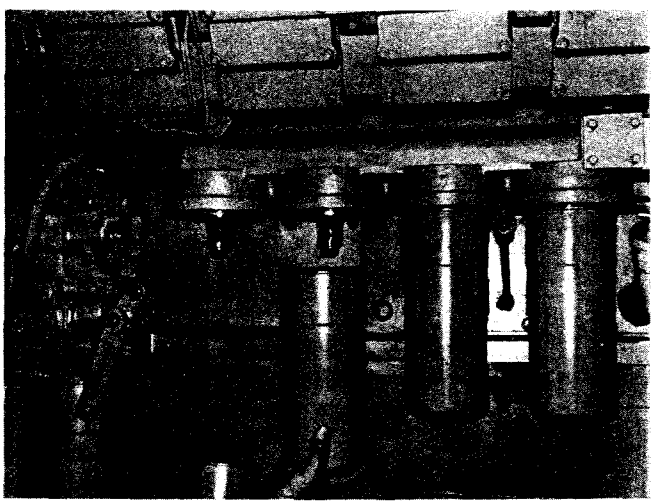


Fig. 2-16, (K21907). Installing "spin-on" lubricating oil filter — KT(A)-2300 Engine

hand until seal touches filter head, tighten an additional one-half to three-fourths turn.

Caution: Mechanical tightening may distort threads or damage filter element seals.

4. Run engine, check for leaks, recheck engine oil level; add oil as necessary to bring oil level to "H" mark on dipstick.

Note: Always allow oil to drain back to oil pan before checking level. This may require 15 minutes.

Change Lubricating Oil By-Pass Filter Element

Note: By-pass filters may be mounted either vertically, horizontally or inverted; all are serviced in like manner.

1. Remove drain plug (5, Fig. 2-17) and drain oil.
2. Remove clamping ring capscrew (1) and lift off cover.

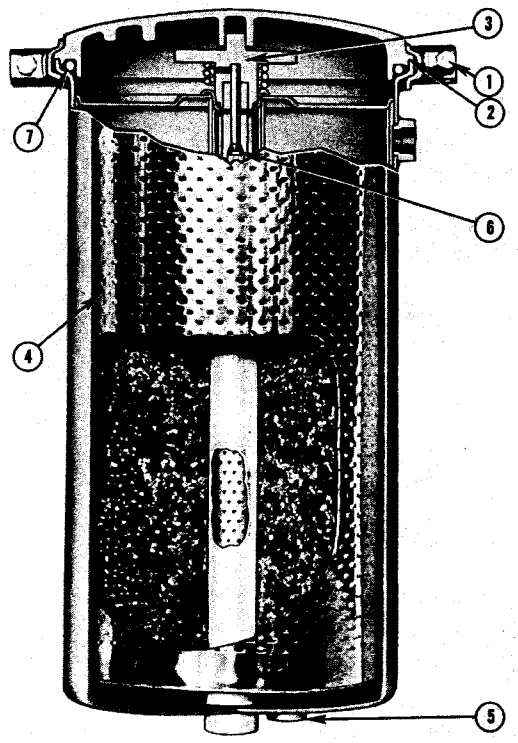


Fig. 2-17, (V41908). By-pass filter cross section

3. Unscrew support hold-down assembly (3); lift out element (4) and hold-down assembly. Discard element.
4. Clean housing and hold-down assembly in solvent.
5. Inspect hold-down assembly spring and seal. Replace if damaged.
6. Inspect drain plug and connections. Replace if damaged.
7. Check orifice plug (6) inside oil outlet connection or standpipe; blow out with air to open and clean.
8. Check filter cover o-ring (7). Replace if necessary.
9. Install new element in housing. Fig. 2-18.

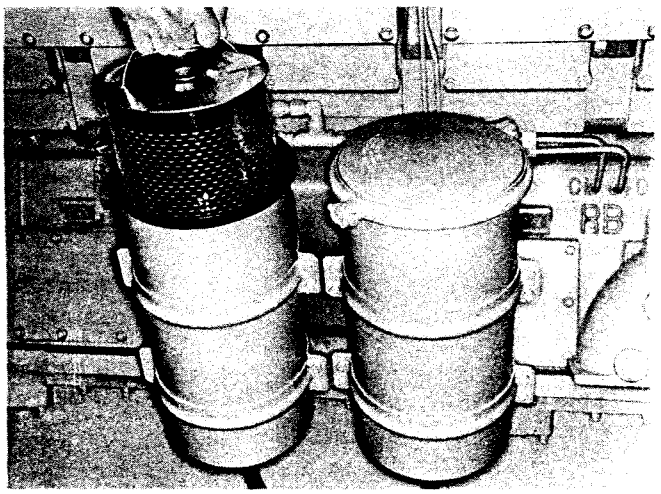


Fig. 2-18, (K21908). Installing by-pass filter element

10. Replace support hold-down assembly in filter and tighten down to stop.
11. Position O-ring seal on housing flange.
12. Install cover and clamping ring; tighten capscrews until clamping lugs are indexed.
13. Run engine, check for leaks; add enough extra oil to crankcase to fill to "H" (high) mark on dipstick.

Caution: Never use a by-pass filter in place of a full-flow filter.

Change Fuel Filter Element

Spin-On Type Filter

1. Unscrew combination case and element, Fig. 2-19, discard element.
2. Fill new filter with clean fuel.
3. Install filter; tighten by hand until seal touches filter head. Tighten an additional one-half to three-fourths turn.

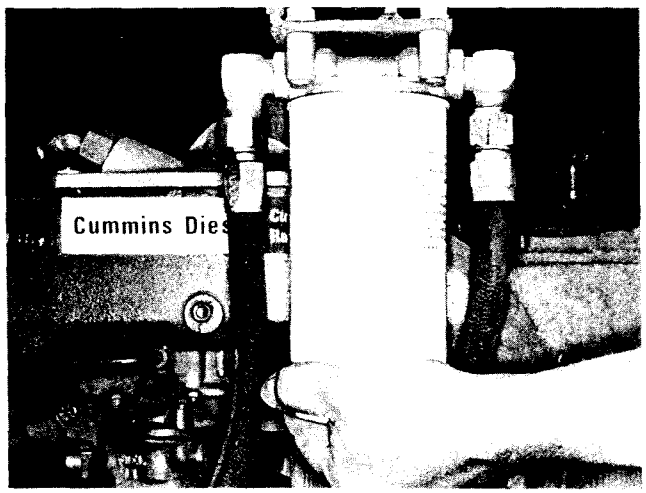


Fig. 2-19, (V11909). Changing "spin-on" type fuel filter

Caution: Mechanical tightening will distort or crack filter head.

Replaceable Element

1. Open drain cock(s) and drain contents.
2. Loosen nut(s) at top of fuel filter(s). Take out dirty element, clean filter case(s) and install new element(s). Fig. 2-20.

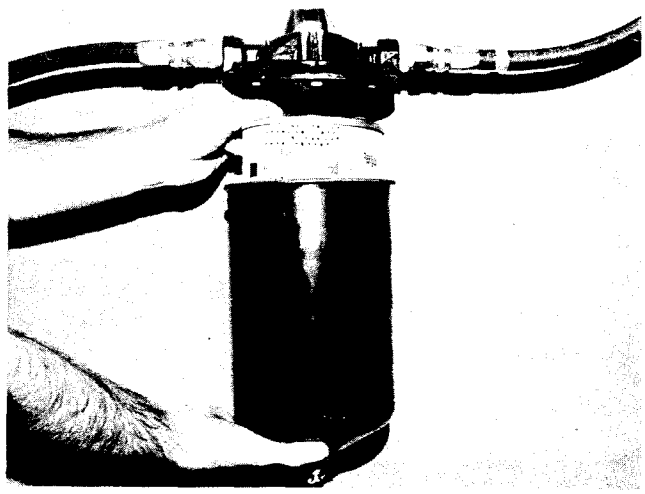


Fig. 2-20, (V11910). Installing replaceable fuel filter element

3. Install new gasket(s) in filter(s) and assemble case(s) and element(s). Tighten center bolt(s) to 20 to 25 ft-lbs [27 to 34 N•m] with a torque wrench. Fill filter case(s) with clean fuel to aid in faster pick-up of fuel.
4. Check fittings in filter head(s) for leaks. Fittings should be tightened to 30 to 40 ft-lbs [41 to 54 N•m].

Check Engine Coolant

Periodic tests of engine coolant should be made to insure that the frequency of water filter servicing or concentration of DCA inhibitor is adequate to control corrosion for any specific condition of operation. In cases where "make-up" water must be added frequently, we suggest that a supply of water be treated and added as necessary.

The concentration of effective inhibitor dissolved in coolant can be measured by Fleetguard DCA Coolant Checking Kit Part No. 3300846-S or Cummins 3375208 which is available from Cummins Distributors for this check. Fig. 2-21.

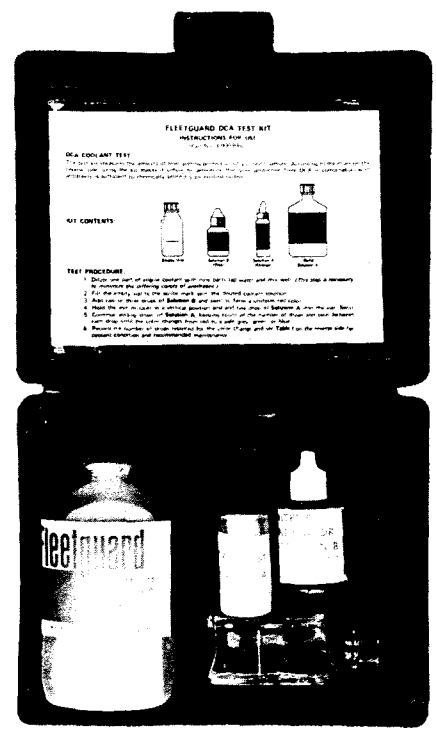


Fig. 2-21, (N12021). DCA coolant test kit

The test kit indicates DCA concentration by measuring the total nitrite of a coolant sample, which provides cylinder liner cavitation protection.

When antifreeze is present, it may contribute to the total nitrite, but most of the nitrite protection is obtained from the DCA inhibitor. In general, a good nitrite reading indicates that the combined inhibitor packages contained in the antifreeze (if used) and in DCA are sufficient to insure complete cooling system protection.

Concentration Test Procedure

1. Dilute one part of engine coolant with nine parts tap water. Mix well.
2. Fill vial to scribe mark, Fig. 2-22, with the diluted coolant solution. Add two or three drops of nitrite indicator solution and swirl to attain a uniform red color.

Fig. 2-22, (V12022). Mixing bottle

3. Add one drop of nitrite test solution "A" to the solution in the vial. Swirl to mix.
4. Continue to add nitrite test solution "A" one drop at a time, mixing between each drop, until a color-change from red to pale blue, gray or green is observed. Make sure that the dropper is held in a vertical position.
5. Record the number of drops required for color change, and consult Table 2-2 for coolant condition and maintenance.

Adding Make-Up Coolant and DCA to Cooling System

1. Test coolant for DCA according to nitrite test procedure "With or Without Antifreeze" depending on the presence or absence of antifreeze in the cooling system.
2. Estimate make-up DCA. For example, if a fifteen gallon cooling system contains only 0.5 oz/gal. [4 ml per l] DCA, and 1.5 oz/gal. [12 ml per l] is required, 15 ounces [426 g] of DCA should be added to the make-up coolant.

Note: A one pint bottle of DCA-4L liquid (P/N 3300858) contains six dry ounces of DCA chemical in Step 2, concentrations are in dry ounces of chemical per gallon of coolant.

Table 2-2: Number of Drops of Test Solution "A"

Coolant With Antifreeze	Coolant Without Antifreeze	Coolant Condition	Maintenance Required
0-12	0-6	Dangerous (0 to 0.6 oz. per gallon DCA)	Precharge system or add make-up DCA to top tank.
12-17	7-12	Borderline (0.7 to 1.2 oz. per gallon DCA)	Replace service filter and/or add make-up DCA to top tank.
18-25	13-20	Acceptable (1.3 to 2.0 oz. per gallon DCA)	None.
25-30	20-30	Tolerable (2.0 to 3.0 oz. per gallon DCA)	None.
Over 30	Over 30	Overrated (over 3.0 per gallon DCA)	Drain part of coolant and make-up with plain antifreeze and water.

Note: Ethylene glycol/water solutions should not contain more than 3.0 oz. per gallon DCA or Dowtherm 209/water solutions should not contain more than 2.0 oz. per gallon DCA. Concentrations in excess of the above can cause sludge to form in the water filter.

3. Estimate the total amount of make-up coolant required (gallons), and calculate the proportions of water and antifreeze, if used, required. For example, one gallon of 50-50 antifreeze/water solution will require two quarts of antifreeze and two quarts of water.
4. Add the required amount of water to a mixing container and dissolve the number of ounces of DCA obtained in Step 2 in the water. If negative or zero results were obtained in Step 2, do not add DCA. (For DCA to dissolve, water should be above 50°F [10°C].
5. Add the required amount of antifreeze, if used, to the water solution and mix thoroughly.
6. Add make-up coolant to cooling system.

Note: If the DCA concentration is low, and coolant level high, DCA may be added directly to the radiator in the amount indicated in Step 2. The engine should be running and warm enough to permit coolant circulation throughout the entire system.

Bulk Storage of Make-Up Coolant

If make-up coolant is stored in bulk, the following recommendations are provided for mixing and storing the coolant.

1. Drain and clean bulk storage tank to remove any possible contaminants.
2. Knowing the total capacity of the holding tank, calculate the proportions of water and antifreeze, if used, required. For example, a 500 gallon [1892 l] tank will hold 250 gallons [946 l] of water and 250 gallons [946 l] of antifreeze for a 50-50 mixture.
3. Multiply the desired DCA concentration by the total capacity of the holding tank in gallons. In the example above, 1.5 oz. DCA per gallon [12 ml per l] of coolant can be used in the 50-50 mixture. Multiplying 1.5 oz. DCA per gallon [12 ml per l] times 500 gallons [1892 l] yields a total DCA requirement of 750 oz. (46 lb. 14 oz.) [21.3 kg].
4. Add the water to the holding tank. Agitating continuously, add the DCA to the water in small amounts until all of the chemical has dissolved. The water should be above 50°F [10°C].
5. Add the antifreeze last, if used, maintaining agitation to bring and keep the finished coolant in solution. Both antifreeze and DCA will settle to the bottom of the tank unless constant mixing or recirculation is provided. An example of recirculation is the use of a small pump operating continuously to draw DCA and antifreeze off the bottom of the tank and discharging the solution at the top. Samples of coolant can be drawn off the top, middle and bottom of the storage tank and tested for antifreeze and/or DCA concentration if inadequate mixing is suspected.

Change DCA Water Filter

Change filter or element at each "B" Check; selection of element to be used should be based upon size of system. See "Coolant Specifications", Section 3.

Note: Whenever coolant supply is changed the system must be drained, flushed, and precharged. See "Coolant Specifications", Section 3 for DCA compatibility with different brands of antifreeze.

Spin-On Element

1. Close shut-off valves on inlet and drain lines.
2. Unscrew element and discard.
3. Install new element, tighten until seal touches filter head. Tighten an additional one-half to three-fourths turn. Fig. 2-23. Open shut-off valves.

Fig. 2-23, (V514132). Installing DCA "spin-on" water filter

Caution: Mechanical tightening will distort or crack filter head.

Check Oil Levels

Check Aneroid Oil

1. Remove pipe plug from hole marked "Lub Oil".
2. Fill with engine lubricating oil to level of pipe plug hole. Reinstall pipe plug.

Check Hydraulic Governor Oil Level

Keep level half-way up on inspection glass or to high-level mark on dipstick. Use same grade oil as used in engine.

Clean/Change Crankcase Breather

Mesh Element Breather

1. Remove wing nut (6, Fig. 2-24), flatwasher and rubber washer securing cover (1), to breather body (5).

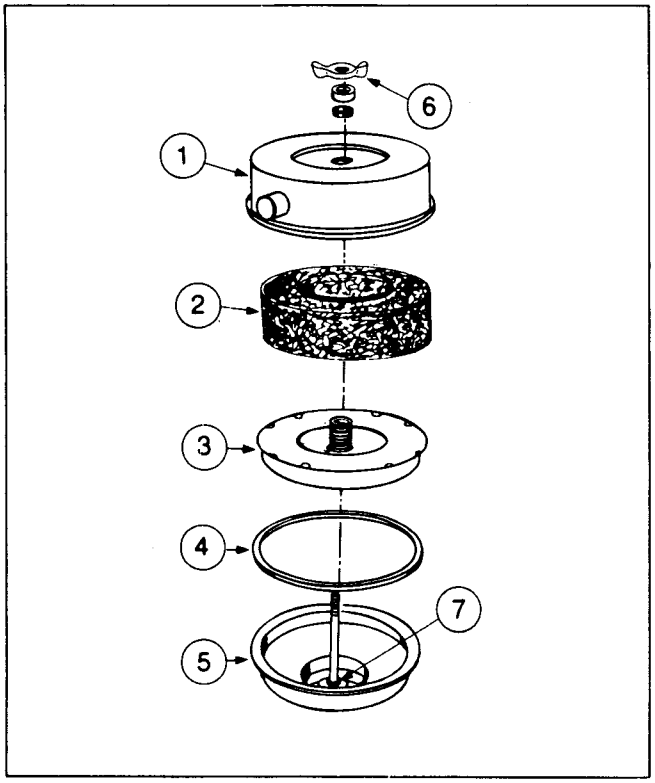


Fig. 2-24, (V51909). Crankcase breather — mesh element with vapor barrier

2. Lift off cover and lift out breather element (2), vapor element (3) and gasket (4).
3. Clean all metal and rubber parts in approved cleaning solvent. Dry thoroughly with compressed air.
4. Inspect rubber gasket; replace if necessary. Inspect body and cover for cracks, dents or breaks; discard all unserviceable parts.
5. Install cleaned or new breather element (2, Fig. 2-24) and cleaned vapor element (3) to breather body (5).
6. Install rubber gasket (4) in cover (1); position cover assembly to body (5).
7. Install rubber washer, flatwasher and wing nut (6); tighten securely.

Screen Element Breather — Cleaning and Inspection

1. Remove vent tube if not previously removed.
2. Remove capscrews, washers, cover, screens and baffle if used, from breather body. Fig. 2-25.

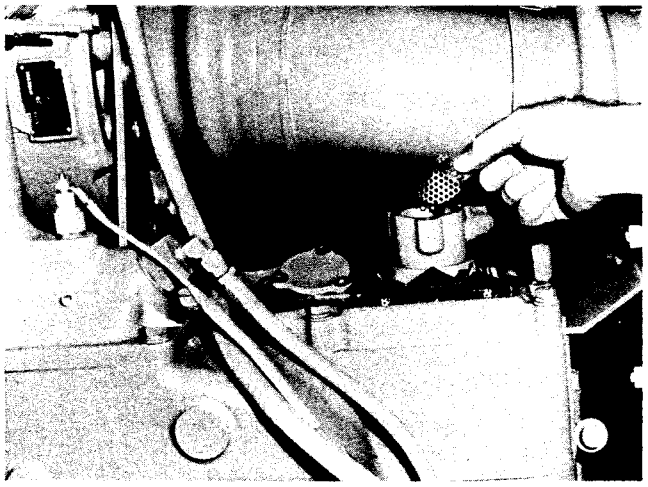


Fig. 2-25, (N11934). Crankcase breather — screen type

3. Clean vent tube, screens and baffle in an approved cleaning solvent. Dry with compressed air. Wipe out breather housing.
4. Assemble baffle and screens, if used, and new gasket in body.
5. Replace cover with cover boss resting securely on point of screen, if used; secure with washers and capscrews.
6. Replace vent tube.

Clean Air Compressor Breather

When used, service breathers regularly as follows:

Bendix-Westinghouse Paper Element

Remove breather cover and element. Fig. 2-26. Clean by reverse flushing with compressed air; reassemble on compressor. Discard element if damaged or unsuitable for cleaning.

Bendix-Westinghouse Sponge

Remove breather from air compressor. Disassemble

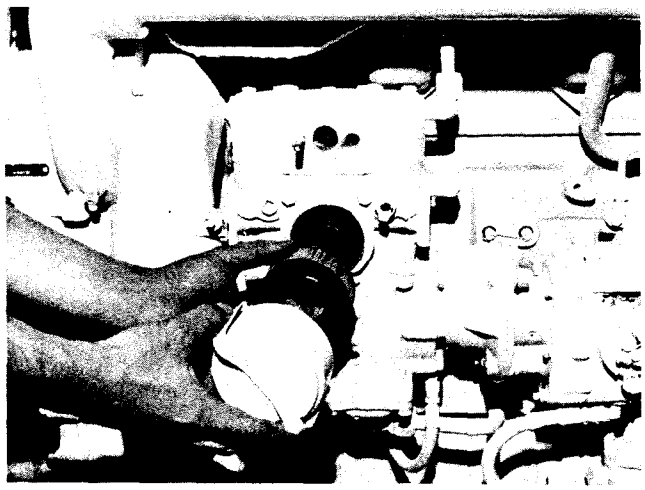


Fig. 2-26, (V41420). Bendix-Westinghouse air compressor breather

breather, wash all metal parts in solvent and blow dry with compressed air. Wash element in solvent; remove all solvent from element; dip in clean engine oil and squeeze excess oil from element.

Cummins Paper

Clean element at each "D" maintenance check. Remove wing nut securing front cover to body. Lift off front cover and element. Inspect paper element before cleaning by reverse flow of compressed air; discard if damaged or unsuitable for cleaning. Fig. 2-27.

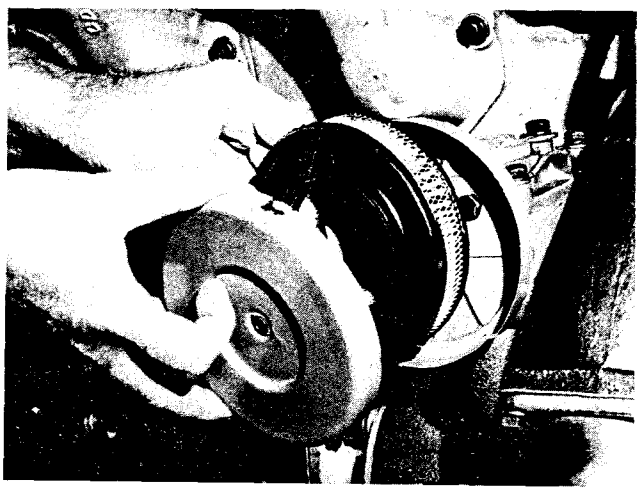


Fig. 2-27, (V414209). Cummins air compressor breather — paper element

Caution: Do not rupture filter element.

Clean the body and front cover with a clean cloth. With rubber gasket on center bolt, place element in front cover and assemble over center bolt; secure with wing nut.

Note: At any time the three-prong unloader hat is used, it will set up air pulsations across the compressor intake which can destroy the paper element. Pipe intake air for Cummins compressors from engine air manifold when the three-prong unloader hat is applied; current factory-installed compressors are so equipped. This same procedure may be used for any Cummins Compressor in the Field.

Clean Tray Screen

Clean tray screen in kerosene or cleaning solvent. Dry with compressed air, reassemble to cleaner.

Note: If tray screen is extremely dirty, it may be necessary to singe the screen with a flame. Do not melt tin plate on screen.

"C" Maintenance Checks

At each "C" Maintenance Check, first perform all "A", and "B" Checks in addition to those following.

Adjust Injectors and Valves

It is essential that injectors and valves be in correct adjustment at all times for the engine to operate properly. One controls engine breathing; the other controls fuel delivery to the cylinders.

Final operating adjustments must be made using correct values as stated.

Caution: Be sure injector and valve set marking, wherever located, are in proper alignment with indicator mark.

Temperature Settings

The following temperature conditions provide the necessary stabilization of engine components to assure accurate settings.

Definition of "Cold Set"

Engine must have reached a stabilized temperature (4 hours minimum) without operation in ambient temperature where adjustments are to be made.

Definition of "Hot Set"

1. Adjust injectors and valves immediately after the engine has been operated at 210° F [99° C] oil sump temperature for a period of 10 minutes minimum, or until normal oil operating temperature has been obtained.
2. If oil temperature gauge is unavailable, set injectors and valves immediately after engine has operated at rated speed and load or at high idle for a period of 40 minutes minimum.

Injector Plunger Adjustment Using Torque Method, V-378, V-504, V-555 Engines

Injectors and valves must be in correct adjustment at all times for engine to operate properly. This controls engine breathing and fuel delivery to cylinder. Final adjustment must be made when engine is at operating temperature. Injectors must always be adjusted before valves. The procedure is as follows:

Valve Set Mark Alignment

1. Turn crankshaft in direction of rotation until No. 1 "VS" mark appears on the vibration damper or crankshaft pulley. See Fig. 2-28 for location of valve set marks. In this position, both intake and exhaust valves must be closed for cylinder No. 1; if not, advance crankshaft one revolution. See Fig. 2-29, Fig. 2-30 and Table 2-3 for firing order.

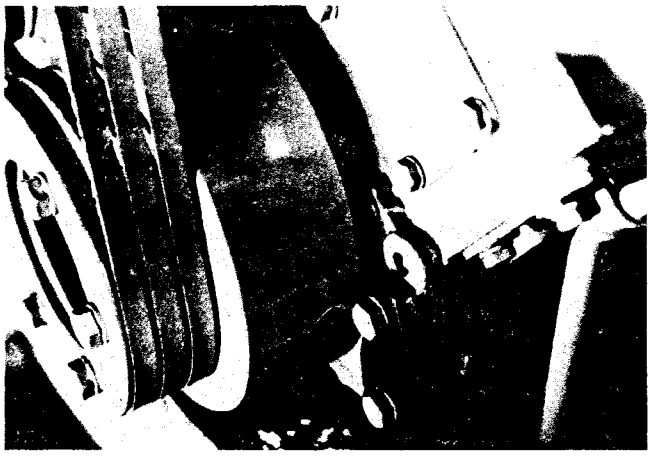


Fig. 2-28, (OM103). Valve set marks — V-378, V-504, V-555 Engines

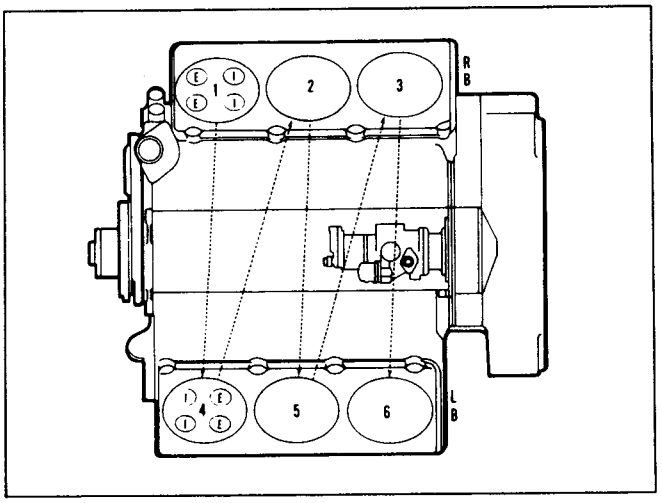


Fig. 2-29, (V11461). V6 firing order

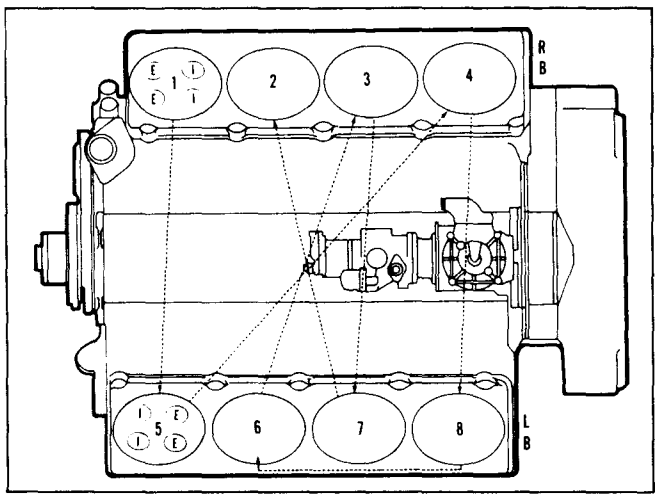


Fig. 2-30, (V11462). V8 firing order

Note: Do not use fan to rotate engine.

2. Adjust injector plunger, then crossheads and valves of first cylinder as explained in succeeding paragraphs. Turn crankshaft in direction of rotation to next "VS" mark corresponding to firing order of engine and corresponding cylinder will be ready for adjustment. See Table 2-3.
3. Continue turning crankshaft in direction of rotation and making adjustments until all injectors and valves have been correctly adjusted.

Table 2-3: Engine Firing Order V Engines

Right Hand	V8	1-5-4-8-6-3-7-2
Right Hand	V6	1-4-2-5-3-6

Note: Two complete revolutions of crankshaft are needed to set all injector plungers and valves. Injector and valves can be adjusted for only one cylinder at any one "VS" setting.

Note: Two complete revolutions of crankshaft are needed to set all injector plungers and valves. Injector and valves can be adjusted for only one cylinder at any one "VS" setting.

Injector Plunger Adjustment

Before adjusting injector, tighten injector hold-down capscrew to 30 to 35 ft-lbs [41 to 47 N • m].

The injector plungers of all engines must be adjusted with an in-lb torque wrench to a definite torque setting. Snap-On Model TQ12B or equivalent torque wrench and a screwdriver adapter can be used for this adjustment. Fig. 2-31.

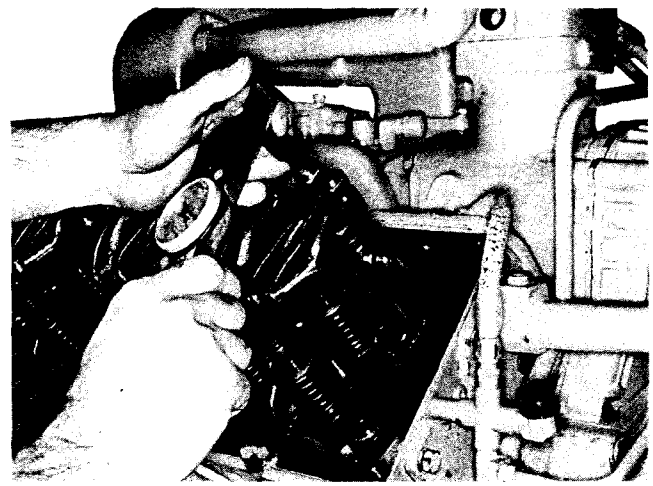


Fig. 2-31, (V11914). Adjusting injector plunger

1. Turn adjusting screw down until plunger contacts cup and advance an additional 15 degrees to squeeze oil from cup.
2. Loosen adjusting screw one turn; using a torque wrench calibrated in in-lbs and a screwdriver adapter, tighten the adjusting screw to values shown in Table 2-4 for cold setting and tighten the locknut.

Table 2-4: Injector Plunger Adjustment Torque V-378, V-504, V-555 Engines

Oil Temperature Cold	Oil Temperature Hot
60 in-lbs [6.8 N • m]	60 in-lbs [6.8 N • m]

Note: After all injectors and valves are adjusted and engine has been started and warmed up to 140° F [69° C] oil temperature, reset injectors to the warm setting. This is only necessary if injectors, lever assemblies, or push rods have been changed.

3. Hold injector adjusting screw and tighten injector adjusting screw locknut to values indicated in Table 2-5.

When ST-669 Adapter is used, nut torque is reduced to compensate for additional torque arm length. Fig. 2-32.

Table 2-5: Injector and Valve Locknut Torque V-378, V-504, V-555 Engines

Without ST-669	With ST-669
40 to 45 ft -lbs. [54 to 61 N • m]	30 to 35 ft-lbs [41 to 47 N • m]

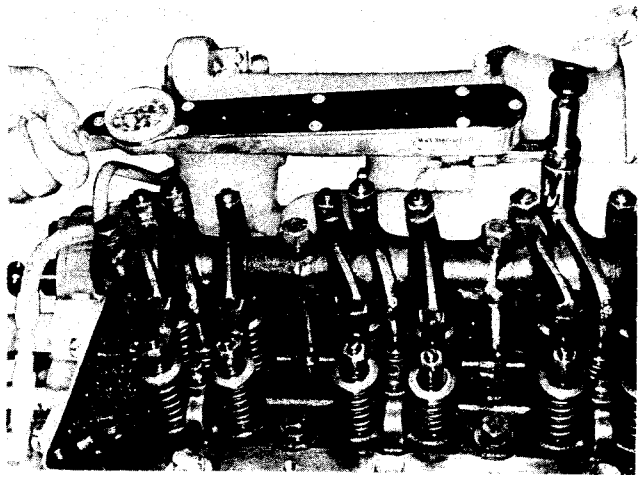


Fig. 2-32, (V114115). Tightening adjusting screws locknut

Crosshead Adjustment

Crossheads are used to operate two valves with one rocker lever. The crosshead adjustment is provided to assure equal operation of each pair of valves and prevent strain from misalignment.

1. Loosen valve crosshead adjusting screw locknut and back off screw one turn.
2. Use light finger pressure at rocker lever contact surface to hold crosshead in contact with valve stem (without adjusting screw).
3. Turn down crosshead adjusting screw until it touches valve stem. Fig. 2-33.
4. Hold adjusting screw in this position and torque locknut to values listed in Table 2-6.
5. Check clearance between crosshead and valve spring retainer with wire gauge. There must be a minimum of 0.025 inch [0.64 mm] clearance at this point.

Valve Adjustment

The same crankshaft position used in adjusting injectors is used for setting intake and exhaust valves.

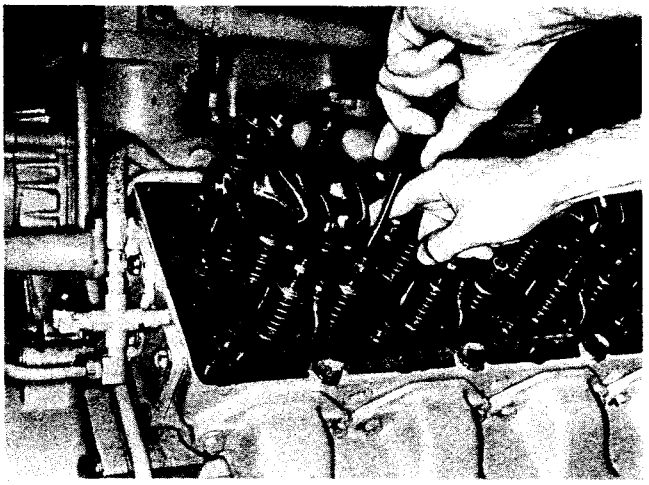


Fig. 2-33, (V11915). Adjusting crossheads

Table 2-6: Crosshead Locknut Torque

Without ST-669	With ST-669
25 to 30 ft-lbs [34 to 41 N • m]	22 to 26 ft-lbs [30 to 35 N • m]

1. Loosen locknut and back off adjusting screw. Insert feeler gauge between rocker lever and top of crosshead. Valve clearances are shown in Table 2-7. Turn screw down until lever just touches gauge and lock adjusting screw in this position with locknut. Fig. 2-34. Torque locknut to values indicated in Table 2-5; note Step 2 under "Injector Plunger Adjustment".

Table 2-7: Valve Clearances — Inch [mm] V-378, V-504, V-555 Engines

Intake Valve Oil Temperature		Exhaust Valve Oil Temperature	
Cold	Hot	Cold	Hot
0.012 [0.30]	0.010 [0.25]	0.022 [0.56]	0.020 [0.51]

2. Always make final valve adjustment after injectors are adjusted and with the engine at operating temperature.

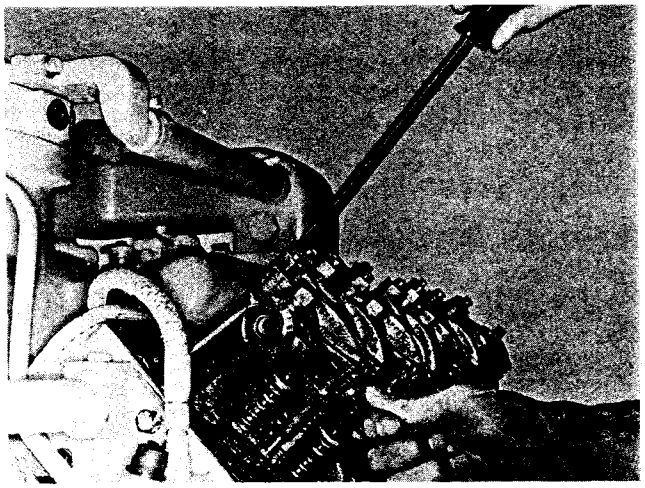


Fig. 2-34, (V11916). Adjusting valves

V-903 Engines Injector Adjustment, Using Dial Indicator Method

This method involves adjusting injector plunger travel with an accurate dial indicator rather than tightening the adjusting screw to a specified torque.

The "indicator method" eliminates errors in adjustment caused by friction in the screw threads and distortion from overtightening the adjusting screw locknut. A check can be made of the adjustment without disturbing the locknut or screw setting. The valves can also be checked or set while adjusting the injectors by this method. See Table 2-8 for specifications.

Table 2-8: Adjustment Limits Using Dial Indicator Method Inch [mm] V-903 Engines

Injector Plunger Travel	Valve Clearance Intake	Exhaust
1 to 1 Rocker Lever Ratio — Injector Lever P/N 211319		
0.187 ± 0.001 [4.75 ± 0.03]	0.012 [0.30]	0.025 [0.64]

Before adjustment, tighten injector hold-down capscrew to 30 to 35 ft-lbs [41 to 47 N • m] torque.

Note: Remove key, and using either 3/8 inch hex drive for female type barring device or 5/8 inch six-point socket for male type barring device, press inward until barring gear engages drive gear; then advance. Fig. 2-35. After completion of adjustment, be sure drive retracts and install key into safety lock groove.

Using regular engine barring device, Fig. 2-35, rotate engine in direction of rotation until "VS" mark for cylinder 2-8 is aligned with pointer. In this position both the intake and exhaust valve rocker levers for No. 2 cylinder should be free and can be moved up and down. If not, bar engine another 360 degrees in direction of rotation and realign the 2-8 "VS" mark.

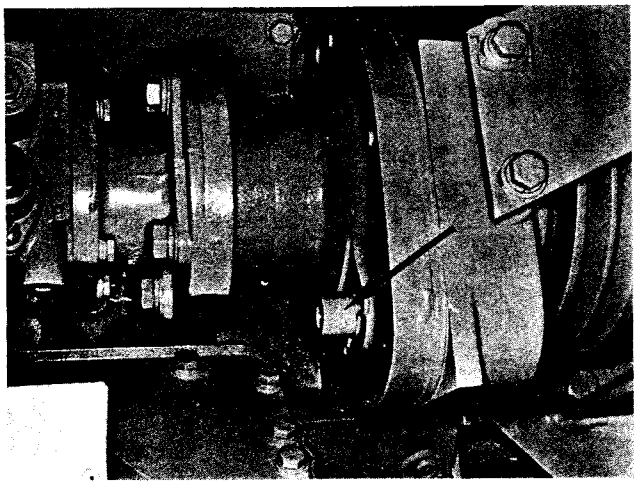


Fig. 2-35, (V51486). Engine barring arrangement — V-903

The timing mark locations (Fig's. 2-36 and 2-37) are used with the dial indicator method of setting injectors and valves. Alignment, in either location, should be held to one-half inch [12.7 mm] of pointer.

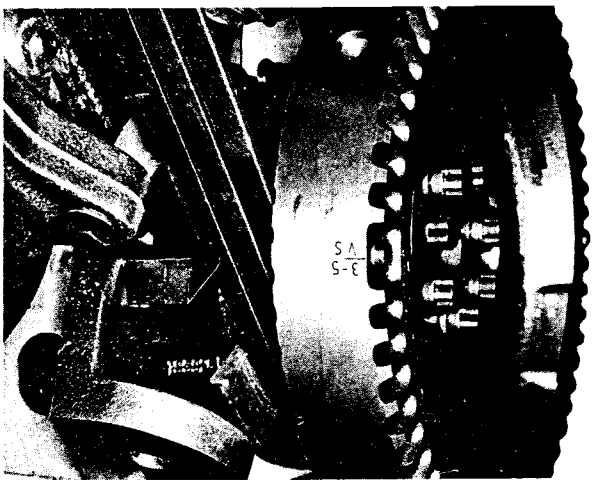


Fig. 2-36, (V514115). Valve set marks on vibration damper — V-903

Note: No. 2 cylinder is selected for purpose of illustration only. Any other cylinder could be used, if so desired.