SERVICE MANUAL SECTION

VISCOUS FAN DRIVES

Unit Code: 12TSA
Unit Code: 12TSB
Unit Code: 12TSG
Unit Code: 12TSJ
Unit Code: 12TSL
Unit Code: 12TSS
Unit Code: 12TST
Unit Code: 12TSU
Unit Code: 12TSV
Unit Code: 12TSW

S12002Y, Formerly CTS-5055T

08/07/2000

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DESCRIPTION

The Viscous Fan drive is completely self-contained. It is filled with silicone fluid, and operates as a fluid coupling. It is matched to a nylon or metal fan.

On bi-metal fan drives, a bi-metal disk senses air temperature from the radiator to engage and disengage the fan. The only service for a bi-metal fan drive is to replace the unit.

Refer to Figure 1.

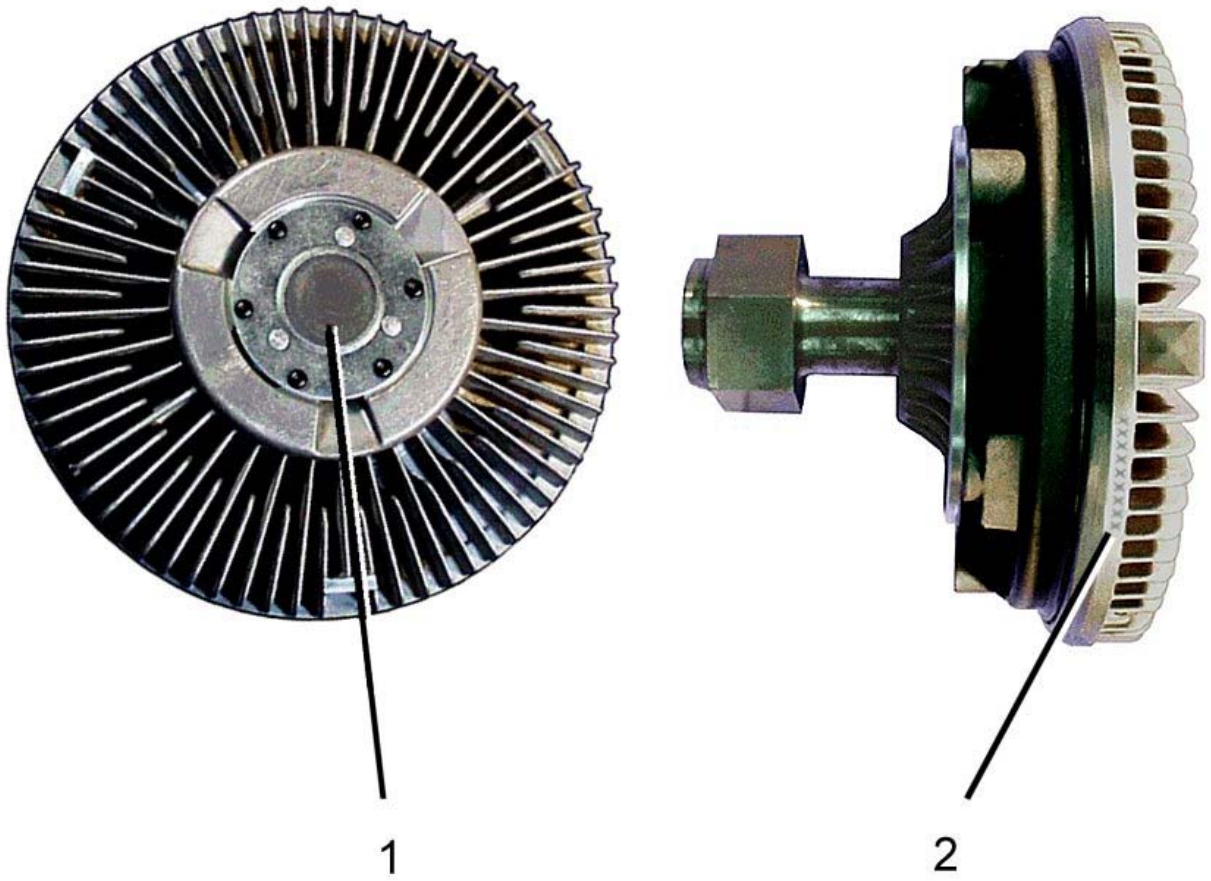

Figure 1 Viscous Fan Drive (Bi-Metal Types)

1. BI-METAL DISK
2. DRIVE PART NUMBER

On the Solenoid Activated Viscous Fan Drives, a solenoid controlled by a coolant temperature sensing system or engine ECM, replaces the bi-metal (Figure 2). The fan drive is disengaged when power is applied to the solenoid. The Solenoid Activated Drives can be serviced by replacing a defective solenoid (using Kit Number 2501200C91); or the entire unit can be replaced.

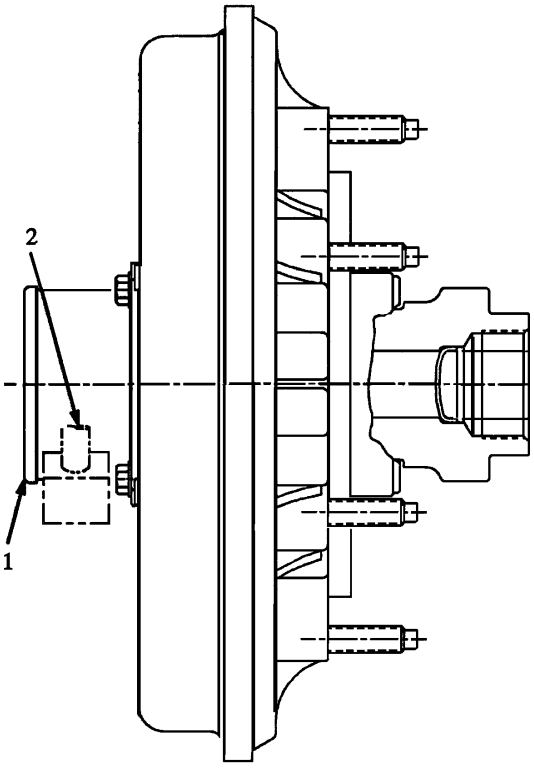

Figure 2 Viscous Fan Drive (Solenoid Activated Type)

1. SOLENOID
2. CONNECTION FOR TEMPERATURE SENSING SYSTEM OR ENGINE ECM

OPERATION

The fan drive operates on the viscous fluid shear principle. The drive is attached to the engine jackshaft or water pump. The input and output ends are coupled by silicone fluid, which must be driven at a certain speed before it will turn the fan blades.

Fan speed is controlled by the amount of coupling between the input and output shafts. When the fan drive is disengaged, fluid is evacuated from the drive chamber into a storage reservoir. This condition provides minimum coupling and minimum or reduced fan speed. When the fan drive is engaged, a valve is opened allowing fluid into the drive chamber. This condition provides maximum coupling and maximum fan speed. Valve opening and closing is controlled by the bi-metal disk on bi-metal drives. On solenoid-activated drives a solenoid on the front of the fan drive unit controls valve opening and closing.

With the viscous fan drive engaged, as the input r.p.m. increases, the difference between input speed and output speed ("slip") becomes greater until a predetermined peak speed is reached. At peak speed, fluid shear prevents the fan from turning faster regardless of further increases in input speed.

MAINTENANCE CHECK

WARNING – Improper use or application, or modification of a viscous fan drive or the fan that it carries can result in property damage or personal injury.

WARNING – DO NOT operate a vehicle with a drive or fan blades that are malfunctioning or are externally damaged. Continued operation could result in property damage or personal injury.

WARNING – DO NOT attempt to restrict fan blade rotation during engine operation. Damage to the fan drive, property damage or personal injury could result.

WARNING – Before performing tests on the fan drive with the engine running, insure that the wheels are properly chocked and the parking brake is engaged, wear eye protection, prevent loose clothing from contact with the rotating fan blades, stay clear of hot surfaces and insure that any test leads are protected from rotating components. Failure to follow these warnings could result in property damage, personal injury or death.

At 25,000 miles, perform the following:

1. Check the torque of fan blade fasteners.

2. Check the torque of fan drive-to-pulley, hub and bracket assembly fasteners.

3. Check the torque of pulley, hub and bracket assembly-to-engine fasteners.

4. Check the fan drive, fan blade assembly, shroud, radiator and the immediately adjacent areas for evidence of interference between rotating and non-rotating parts. If damage is present, isolate and repair or replace defective parts.

5. Rotate the fan through at least 360 degrees. It should turn smoothly, but with some resistance. Replace fan drive if the fan binds, jerks, or spins freely.

NOTE – The following step is used to detect looseness in the fan or fan drive mounting; when performing the step, do not force the blade tip (cause the blade to deflect) because this will distort the resulting measurement.

6. Grasp one fan blade tip, and move it back and forth from the radiator. At 10 inches (254 mm) radius from the center, the blade tip should not move more than 1/16 inch (1.6 mm). If the blade moves more than specified and the excess cannot be attributed to pulley/water pump bearing wear, blade deflection, or loose fasteners (fan to fan drive or fan drive to hub/pulley), replace the fan drive.

REMOVE

NOTE – On bi-metal fan drives, DO NOT remove (or tamper with) the bi-metal, the bracket, or the pin at the front of the drive. The locations of these mechanisms are critical, and preset for the life of the unit. Any tampering can cause loss of calibration and/or loss of viscous fluid from the housing.

NOTE – DO NOT steam clean or use high pressure jets to clean the fan drive. This could force foreign material past the external seals, contaminating the viscous fluid, and causing the drive to malfunction.

NOTE – Some spin-on fan drives are left hand thread.

1. Remove the old fan drive from the engine shaft/water pump shaft.

2. Remove and retain the fan blades.

3. To remove the solenoid from a solenoid activated fan drive, refer to the procedures supplied with the solenoid replacement kit.

INSTALL

1. On model SD-65, and all SA series fan drives, install fan on drive using capscrews. On all other models, install fan on drive with lockwashers and hexnuts. Lubricate the threads, and tighten fasteners to the values found in the TORQUE CHART (See TORQUE CHART, page 12).

NOTE – On Model DD-34 drives, DO NOT allow the cover-to-housing bolts to rotate while attaching the fan to the fan drive. If the screws are loosened, the viscous fluid will leak, and the unit will be out of calibration and have a short service life.

2. If the solenoid was replaced on a solenoid activated fan drive, install the new solenoid on the fan drive by referring to the procedures supplied with the solenoid replacement kit.

NOTE – Some spin-on fan drives are left hand thread.

3. Install the fan drive on the engine. Lubricate the threads, then tighten to the values found in the TORQUE CHART (See TORQUE CHART, page 12).

TROUBLESHOOTING

This section provides the information needed to troubleshoot a faulty or suspected faulty viscous fan drive. To troubleshoot a solenoid activated fan drive, refer to SOLENOID ACTIVATED VISCOUS FAN DRIVES. To troubleshoot a bi-metal viscous fan drive, refer to VISCOUS FAN DRIVE TEST PROCEDURE (See VISCOUS FAN DRIVE TEST PROCEDURE (BI-METAL DRIVES ONLY), page 6).

SOLENOID ACTIVATED VISCOUS FAN DRIVES (RE BUS ONLY)

NOTE – Engine at ambient temperature while performing the steps in the following table.

Table 1 Symptom — Fan Drive Runs Fully Engaged at All Times.

Step	Key	Action	Spec.	Yes-In Spec.	No-Out Of Spec.
1.	OFF	Spin fan blade by hand several times.	Fan should rotate smoothly with consistent drag. No binding or roughness allowed.	Go to Step 2.	Fan drive is locked up or binding internally. Replace fan drive.
2.	ON	Disconnect electrical connector that feeds fan drive solenoid.	9 to 12 VDC.	Go to Step 3.	Locate and repair electrical fault.
3.	ON	[(Coolant temperature less than 190°F (87.8°C).] Disconnect electrical connector (at end of solenoid harness) that feeds solenoid. Reconnect solenoid and listen for solenoid operation.	Solenoid operates.	Go to Step 5.	Go to Step 4.
4.	ON	Check electrical connector at base of solenoid to be sure it is securely connected. Disconnect electrical connector that feeds solenoid (at end of solenoid harness). Reconnect solenoid and listen for solenoid operation.	Solenoid operates.	Go to Step 5.	Tether/wiring damaged or solenoid inoperative. Replace solenoid with Solenoid Replacement Kit – OR – replace fan drive.
5.	OFF	Check gap between rotating mounting plate and the solenoid body.	0.045 inch (1.143 mm) or less.	Go to Step 6.	Solenoid bearing dislodged. Replace solenoid with Solenoid Replacement Kit – OR – replace fan drive.
6.	OFF	Disconnect electrical connector at solenoid base. Rotate solenoid 360° on mounting plate.	Solenoid should rotate completely and smoothly.	Fan drive checks good.	Solenoid bearing failure. Replace solenoid with Solenoid Replacement Kit – OR – replace fan drive.

NOTE – Engine at ambient temperature while performing the steps in the following table.

Table 2 Symptom — Fan Drive Will not Fully Engage

Step	Key	Action	Spec.	Yes-In Spec.	No-Out of Spec.
1.	ON	Disconnect electrical connector that feeds solenoid.	Solenoid engages.	Go to Step 2.	Locate/ repair fault in vehicle temperature sensing system or electrical system.
2.	OFF	Disconnect electrical connector at solenoid base. Rotate solenoid 360° on mounting plate.	Solenoid should rotate completely and smoothly.	Fan drive checks good.	Solenoid bearing failure. Replace solenoid with Solenoid Replacement Kit – OR – replace fan drive.

VISCOUS FAN DRIVE TEST PROCEDURE (BI-METAL DRIVES ONLY)

NOTE – This test is most effective at an ambient air temperature of 80°F (26.7°C) or higher.

Diagnostic Procedure

1. Perform all of the steps in MAINTENANCE CHECK (See MAINTENANCE CHECK, page 3).

2. Check for obstructions in the radiator, charge air cooler, air conditioning condenser, and transmission cooler (if equipped). Remove any dirt, bugs, lint, or debris in the air path through the radiator to the engine. Pressure wash if necessary.

NOTE – To prevent damage, do not direct high-pressure spray onto the fan drive bi-metal. Also, the high-pressure wash must be directed squarely at the front, or rear, of the radiator to prevent radiator fin damage.

3. Ensure the cooling system is properly filled with the correct coolant mixtures (not to exceed 60% ethylene glycol).

NOTE – In the following step, warming up a cold engine prior to test preparation will shorten the run-time during the test procedure.

4. If engine is cold, start engine and:

- turn air conditioning OFF,
- turn heater OFF (NOTE: on buses, turn heater supply valves OFF at the engine),
- run until thermostat opens; then, **turn engine OFF**.

NOTE – In the following step, nylon fan blades (yellow in color) may require painting with flat black paint in order to measure fan speed.

5. Apply a strip of reflective tape to one (1) blade of the fan and another strip to the fan drive shaft so that fan RPM and fan drive shaft RPM can be measured with the digital photo-tachometer (Figure 3).

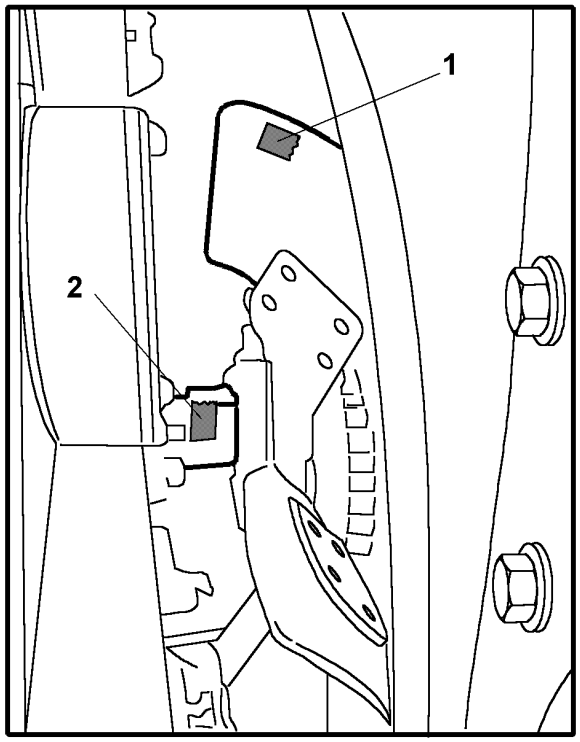

Figure 3 Placement of Reflective Tape

1. REFLECTIVE TAPE ON FAN BLADE
2. REFLECTIVE TAPE ON FAN DRIVE SHAFT

6. Connect EZ-Tech service tool. If testing a non-electronic engine, measure coolant temperature with a suitable thermometer.

7. Fabricate a cardboard cover that covers the entire frontal area of the radiator. Cut a 5 inch (12.7 cm) hole in the area that aligns with the fan drive bi-metal. Position the cardboard in front of the radiator and tape as necessary to hold in place.

8. Carefully position the temperature probe so that it measures air temperature within 1 inch (2.54 cm) of the fan drive bi-metal. You can safely insert the probe through the A/C condenser, CAC, and radiator core (Figure 4 and Figure 5) .

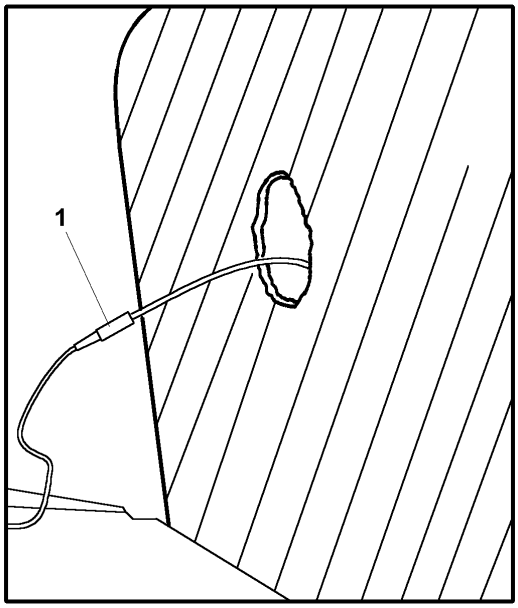

Figure 4 Temperature Probe Inserted through Cardboard and Front of Radiator

1. TEMPERATURE PROBE

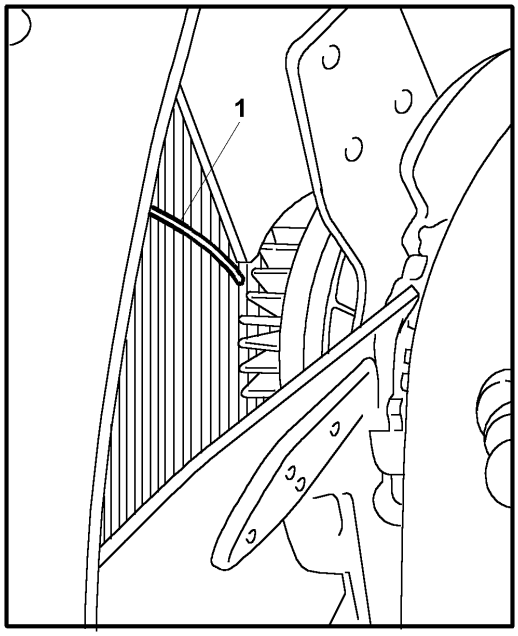

Figure 5 Positioning of Temperature Probe

1. Temperature probe must be positioned in this area [(1 inch (2.54 cm) from bi-metal)].

9. Start the engine and:

- turn the air conditioning OFF,
- turn electrical loads ON (lights, etc.),

- turn heater OFF (on buses, turn heater supply valves OFF).

NOTE – In the following step the fan drive shaft speed is not the same as engine speed.

10. Raise the engine speed until the fan drive shaft reaches 2500 RPM (measured with digital photo-tach). Do not measure fan speed yet.

NOTE – Bright sunlight may make it difficult to take RPM measurements using the photo-tachometer.

11. Lock the throttle at this RPM (use PTO/cruise switches if available). This establishes the fan drive shaft **TEST** RPM.

    NOTE – If engine cannot achieve 2500 RPM fan drive shaft input speed, test at the highest obtainable RPM.

12. Measure fan blade speed with the digital photo-tachometer (Figure 6).

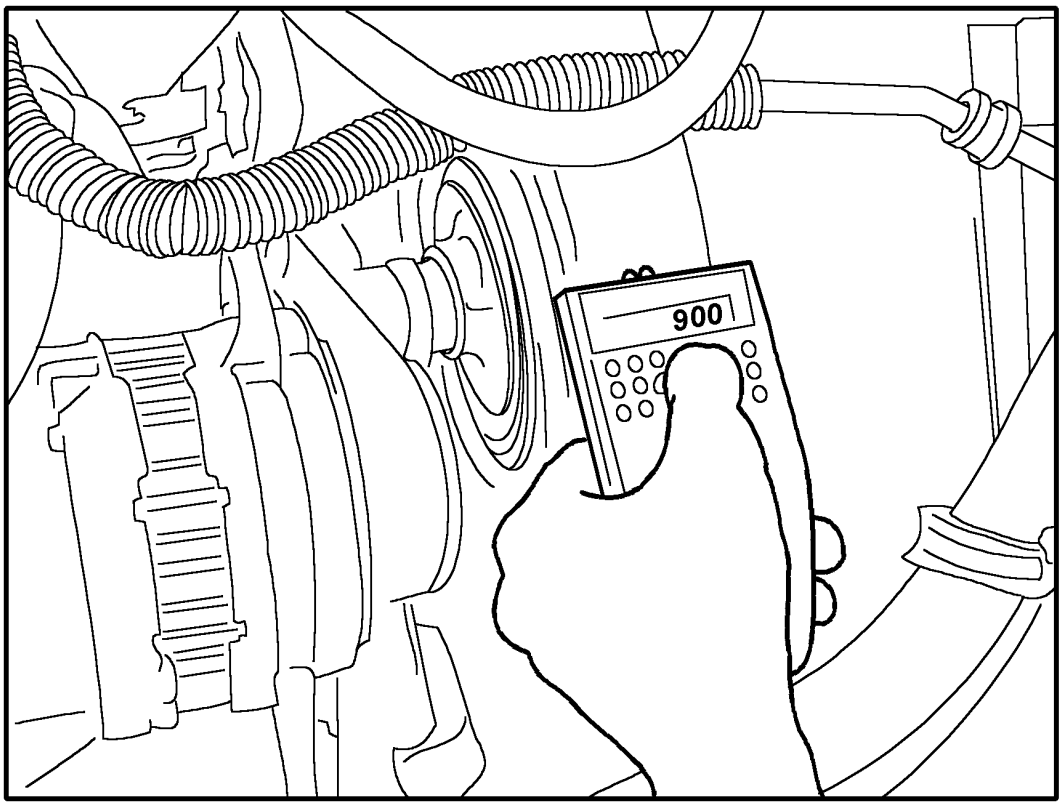

Figure 6 Measuring Fan Blade Speed with Digital Photo-Tachometer

NOTE – If the vehicle is equipped with shutters, they should open automatically before the fan drive engages.

13. As the engine is warming up:

    a. The fan RPM should stabilize between 800 and 1000 RPM. Some DD-30 and DD-34 fan drives may stabilize at up to 1300 RPM. Refer to Table 3 for fan drive information (See Table 3, page 11) .

b. As engine coolant temperature reaches 200–220°F (93.3–104.4°C), (refer to Figure 7), fan speed should increase to 2125 RPM or higher (85% of the test RPM).

c. The air temperature at the bi-metal should be between 165°F (73.9°C) and 195°F (90.6°C) when the fan engages (Figure 7). Refer to Table 3 for specific fan drive P/N calibration information (See Table 3, page 11).

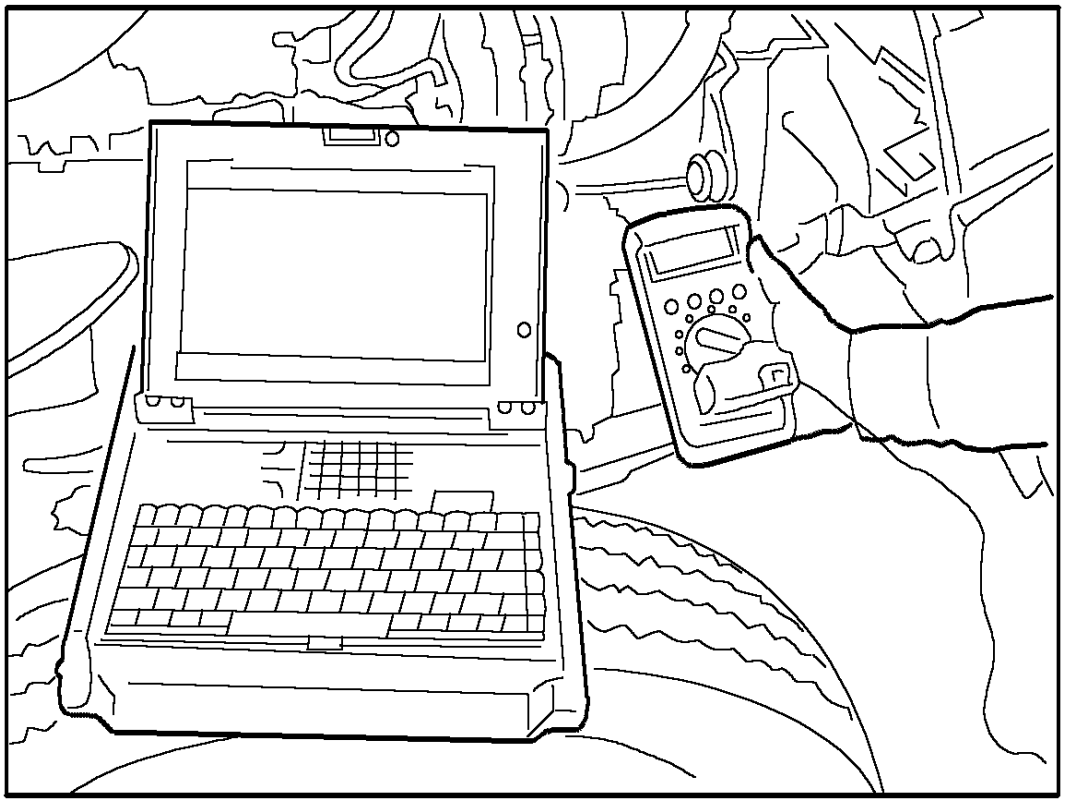

Figure 7 Measuring the Coolant and Air Temperatures

14. With the fan engaged, record fan RPM, coolant temperature, and air temperature at bi-metal.

15. Maintain the **TEST** RPM, with the fan engaged, by keeping the engine speed constant. As temperatures decrease, fan speed should begin to decrease. After 2-3 minutes the fan should slow to the initial fan speed (approximately 40% of the **TEST** RPM).

16. Allow fan to repeat this cycle several times while recording temperatures and fan RPM.

Conclusion:

1. If the fan fails to reach 2125 RPM or higher (or 85% of input speed) at 200 – 220°F (93.3–104.4°C) coolant temperature, and the air temperature at the bi-metal exceeds 195°F (90.6°C), replace the viscous fan drive.

2. If the fan fails to reach 2125 RPM or higher (or 85% of input speed), and the coolant temperature exceeds 220°F (104.4°C), and the air temperature at the bi-metal does not exceed 195°F (90.6°C); then the fan drive is not faulty. Inspect the vehicle for the following:

   a. Air flow restrictions (through the CAC and radiator)

   b. Internal radiator plugging

c. Faulty thermostat

d. Defective water pump

3. When the fan drive disengages (with the 2500 **TEST** RPM maintained), if the fan speed fails to slow to 800–1000 RPM; replace the fan drive (except DD-30 and DD-34, see step 13a of the VISCOUS FAN DRIVE TEST PROCEDURE (See VISCOUS FAN DRIVE TEST PROCEDURE (BI-METAL DRIVES ONLY), page 6)).

4. Remove the temperature probe from the radiator.

5. Remove the cardboard from the front of the radiator.

6. Return the engine to “idle” and allow the engine to cool for two (2) minutes before shutting down.

Table 3 Fan Drive Identification and Calibration Information

Engine	Model	Part Number	Temperature (Air) for Fan Drive Engagement
T444E	DD26	2022685C1	165-175°F (73.9-79.4°C)
	DD26	2033827C1	177-187°F (80.6-86.1°C)
	DD30	2022686C1	177-187°F (80.6-86.1°C)
	SA65	3540983C1	177-187°F (80.6-86.1°C)
	SA75	3540985C1	185-195°F (85-90.6°C)
	SA75	3540984C1, 3547775C1	177-187°F (80.6-86.1°C)
	SD65	2038840C1	177-187°F (80.6-86.1°C)
DT466E and Intl. 530E	DD26	2001023C1	175-185°F (79.4-85°C)
	DD26	2004860C1	165-175°F (73.9-79.4°C)
	DD26	2027495C1	185-195°F (85-90.6°C)
	DD30	1657424C91, 2005257C1, 2021954C1	175-185°F (79.4-85°C)
	DD30	2021376C1	165-175°F (73.9-79.4°C)
	DD30	2029206C1	185-195°F (85-90.6°C)

Table 3 Fan Drive Identification and Calibration Information (cont.)

Engine	Model	Part Number	Temperature (Air) for Fan Drive Engagement
DT 466E and Intl. 530E cont.	DD34	1666056C91, 1673889C91, 2009769C1	175-185°F (79.4-85°C)
	SA75	3522786C1	175-185°F (79.4-85°C)
	SA75	3522788C1, 3540985C1	185-195°F (85-90.6°C)

NOTES:

A. Engagement air temperatures indicate test cell calibration and may vary in the vehicle.

B. * Bi-metal coil fan drives will have a gradual engagement speed and may not obtain the 2125 fan RPM.

TORQUE CHART

Table 4 Torque Chart

Location	Ft-Lbs.	N•m
Fan-to-Drive Hardware	13 - 16	18 - 22
Drive-to-Engine Bolt, 5/16 Inch	20 - 22	27 - 30
Drive-to-Engine Bolt, 3/8 Inch	34 - 38	46 - 52
Drive-to-Hub Shaft	120 - 150	163 - 203

NOTE – The fasteners MUST be S.A.E. Grade #5 or better.

SPECIAL TOOLS

Table 5 Tools Required

Tool Part Number	Tool Description	Purpose
	EZ-Tech Electronic Service Tool	To measure coolant temperature
ZTSE-4468	Kit, Viscous Fan Diagnostic (consisting of:)	
	(1) ZTSE-4468–1, Digital Photo-Tachometer	For measuring fan speed
	(1) ZTSE-4471–1, TK80 Temperature Probe (works with Fluke 88 DMM)	For measuring air temperature
	(1) ZTSE-4471–2, Thermo-Couple	For measuring air temperature