

PERFORMANCE OF GEAR LUBRICANTS IN AXLES UNDER HIGH SPEED AND SHOCK LOADING

1. SCOPE

1.1 This method is used for determining the anti-scoring properties of gear lubricants under high-speed and shock conditions.

Note 1. This method differs from CRC Designation L-19-645 in that the peak torques are about two to three times higher.

2. SAMPLE

2.1 Approximately 2 gallons of the gear lubricant to be tested.

3. APPARATUS

3.1 **Test unit.** The test unit shall consist of a Spicer Model 44-1 rear axle, 45 to 11 ratio, uncoated gears (part No. SKA-66032-3, Dana Corp., Toledo 1, Ohio). No change in factory adjustments shall be made.

Note 2. When ordering, specify a "Spicer rear axle for L-42 testing; ring pinion ratio, 45:11; no surface treatment".

(a) **Rear cover plate.** The rear cover plate of the test unit shall be modified as shown in Figure 1 to provide an inspection opening and to accommodate a thermocouple.

(b) **Axle shafts.** Ford axle shafts (part No. AB4234-E) shall be used with this test unit.

3.2 **Axle supports.** The axle shall rest on two suitable supports and shall be anchored by four U-bolts. (See Figure 2.) Each support shall consist of a wide-flange beam (6 in. by 6 in. by 15-1/2 lb per linear foot) 28-3/4 inches long. The flanges shall be set at right angles to the axle.

3.3 **Temperature control.** The test setup shall include a means of maintaining the lubricant at a specified temperature. This shall include a thermocouple, a temperature-recording instrument, and a cooling bath.

(a) **Thermocouple.** The thermocouple shall be installed in the rear cover plate, and positioned as shown in Figure 1.

(b) **Temperature-recording instrument.** The temperature-recording instrument shall continuously record the temperature of the lubricant throughout the test.

(c) **Cooling bath.** A water bath shall be provided for controlling the temperature of the lubricant in the axle housing. The water-control

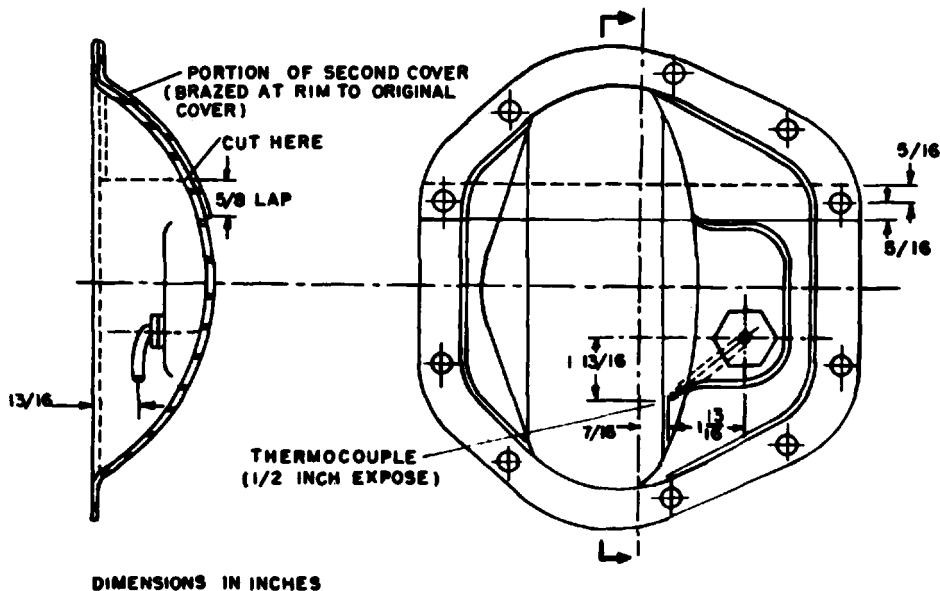


FIGURE 1.—Rear cover plate.

valve shall start and stop the flow of water, and shall be actuated by the thermocouple through the temperature-recording instrument.

3.4 Torque measuring equipment. The test equipment shall include means for measuring the load applied to the test unit during the test. It shall consist of the following:

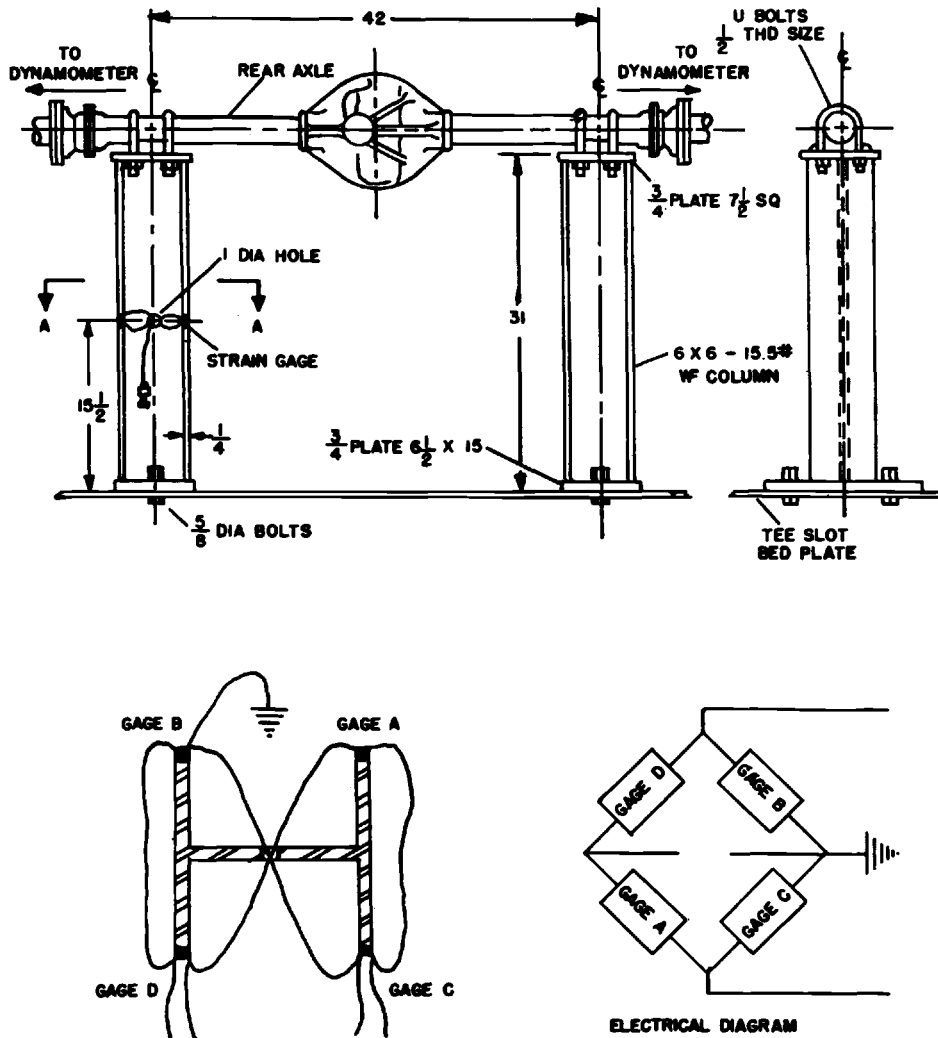
(a) Strain gages (4), electric-resistance (Baldwin type A-7 or C-7, or equivalent) shall be mounted on one of the axle supports as shown in Figure 2.

(b) Amplifier. (Brush Model BL-520, or equivalent.)

(c) Oscillograph. (Brush Model BL-201, or equivalent.)

(d) Dynamometers. Two axle dynamometers (Midwest Dynamatic, Model 3232, or equivalent) with suitable control equipment, shall be used. The minimum average inertia loads shall be as follows: Coast-side load, 950 lb-ft; drive-side load, 1100 lb-ft. The minimum average peak torque loads shall be as follows: Coast-side load, 1600 lb-ft; drive-side load, 2300 lb-ft.

Note 3. The Midwest dynamometer has a 0.05-inch air gap. Its moment of inertia is 1731 in-lb-sec², or 4640 lb-ft².



DIMENSIONS IN INCHES

FIGURE 2.—Axle mounting arrangements.

3.5 Power source. The power source shall include:

(a) Chevrolet (1956) V-8 powerglide engine. The engine shall be mounted on suitable stands, supported at six points by flexible mounts at the front, the bell housing, and the rear of the transmission case. The engine ignition timing and cam dwell shall be adjusted in accordance with the manufacturer's specifications. The carburetor idle-speed adjustment shall be set so that the engine will stall when the hand throttle is closed while the transmission is in neutral.

(b) Four-barrel carburetor. Carter Model WCFB2366SA, part No. 3726255.

(c) Inlet manifold. Part No. 3728588.

(d) Camshaft. Part No. 3728779 (casting No. 3728284).

(e) Heads. Part No. 3729786 (casting No. 3837064).

(f) Valve springs, single. Part No. 3836331.

(g) Clutch disk. Part No. 3836011.

(h) Clutch pressure plate. Part 3837155.

(i) Bell housing. Part No. 3729996.

(j) Four-speed truck transmission. Part No. 591703.

(k) U-joint flange. Part No. 591700.

(l) U-joint yoke. Part No. 605056.

(m) Drive shaft. Shelby welded 1040 steel tubing (3.5 inch OD, 0.093 wall thickness, 58-1/2 inches long from end of spline to eye of U-joint), dynamically balanced up to 5000 rpm.

(n) Throttle actuator. (Sperry type H or F hydraulic transmitter and receiver, or equivalent.)

4. MATERIALS

4.1 Dry cleaning solvent conforming to specification P-D-680, Type I or II.

CAUTION

Dry cleaning solvent is both toxic and flammable. Do not breathe its fumes or allow it to come in contact with the skin. Keep flames away from the dry cleaning solvent.

5. PROCEDURE

5.1 Prepare the apparatus for the test as follows:

(a) Sketch and describe (or photograph) the nature and extent of the contact area; and on a form similar to that shown in Figure 3, record

the torques required to break and to turn the pinion shaft of the completely assembled test unit.

(b) Spray clean the gears and the interior of the case, using dry-cleaning solvent (P-D-680).

(c) Pre-lubricate the pinion and the carrier bearings with a small amount of the test lubricant.

(d) Measure and record the backlash at four positions (15 teeth apart), and check the ring-gear runout.

Note 4. The backlash should be between 0.004 and 0.009 inch; the runout should not exceed 0.003 inch. If the measurements are not within these limits, return the unit to the factory. DO NOT CHANGE THE ORIGINAL FACTORY ADJUSTMENTS.

(e) Install the test unit on the test stand supports.

(f) Connect the unit to the dynamometers by means of axle shafts, and connect the pinion to the drive shaft.

(g) Fill the axle housing with three pints of the test lubricant.

5.2 Break-in. Break in the test unit as follows:

(a) Set the temperature control equipment to maintain a lubricant temperature of $225^{\circ} \pm 5^{\circ}\text{F}$ ($107.2^{\circ} \pm 2.8^{\circ}\text{C}$).

(b) With the engine warmed up, and with no load applied to the dynamometers, start in first gear (low-low). When the axle speed reaches approximately 80 rpm, shift into second, operating the clutch and throttle so that shifting is smooth and without bucking. Continue shifting smoothly into third and fourth at 150 to 240 rpm, respectively.

(c) After shifting into high gear, accelerate to an axle speed of 600 rpm with a manifold pressure of 12 to 14 inches of mercury, apply a 40 lb-ft load to each dynamometer, and run the unit for ten minutes.

(d) After ten minutes, slowly (five seconds) close the throttle to decelerate the axle speed to 400 rpm. Then slowly (five seconds) open the throttle to accelerate to 600 rpm. Do not remove the 40 lb-ft load during this operation.

(e) Repeat step (d) three more times.

(f) Increase the axle speed to 850 rpm, apply a 52 lb-ft load, and run the unit for 20 minutes under these conditions.

(g) After 20 minutes, slowly (five seconds) accelerate and decelerate through four cycles between 850 and 700 rpm axle speed, as in step (d).

(h) Disengage the clutch, allow the axles to stop, shut off the cooling water, and check the instrument balance.

(i) Allow the unit to cool under static conditions until the lubricant temperature has reached 200°F (93.3°C). Then continue with the high-speed operation portion of the test.

5.3 High-speed operation. Operate the unit under high speed conditions with inertia loading only, as described below. Record the torque values, and obtain zero load trace at the beginning and end of the operation.

(a) When the temperature of the lubricant has reached 200°F (93.3°C) and with no load applied to the dynamometers, start the unit in first gear and shift smoothly into second, third, and high gears when the axle speeds reach 80, 150, and 250 rpm, respectively.

(b) After shifting into high gear, accelerate to 550 rpm with a manifold pressure of 12 to 14 inches of mercury.

(c) Next, open the throttle rapidly to accelerate to an axle speed of 1100 rpm. Then close the throttle rapidly to decelerate to 550 rpm.

(d) Repeat step (c) four more times.

(e) With the throttle closed, de-clutch, shift into neutral, and allow the axles to coast to a stop.

Note 5. After shifting into neutral, a light load may be applied to the dynamometer fields for decelerating the axles.

(f) Without draining the lubricant from the axle housing, remove the inspection cover, and observe and record the nature, extent, and location of the drive and coast contact areas, as well as any disturbances to the ring-gear tooth faces.

(g) Allow the temperature of the lubricant to drop to 280°F (137.8°C) under static conditions, then continue with the shock operation portion of the test.

Note 6. If the temperature of the lubricant did not rise to 280°F during the high-speed operation portion of the test, start the shock portion as soon as possible to avoid any unnecessary cooling.

5.4 Shock operation. Operate the unit under shock (peak torque) condition, as described below, record the torque values, and obtain zero load trace at the beginning and end of the operation.

(a) With no load applied to the dynamometers, start in first gear and shift smoothly into second and third when the axle speeds reach 80 and 150 rpm respectively.

(b) Accelerate in third gear (1.71 to 1 ratio) to 550 rpm with a manifold pressure of 12 to 14 inches of mercury.

(c) Apply a 131 lb-ft load to each dynamometer, and open the throttle rapidly to accelerate to 650 rpm. Then close the throttle rapidly to decelerate to 550 rpm.

(d) Repeat step (c) nine more times.

(e) With the throttle closed, de-clutch, shift into neutral, and allow the axles to coast to a stop.

5.5 Calibrate the axle torque as follows:

(a) Install a special capstan on the engine crankshaft to apply calibrating torque.

(b) Lock both dynamometer rotors to their stators.

(c) Shift the transmission into first gear, and turn the crankshaft until approximately 500 lb-ft torque is applied to each dynamometer. Record the deflection and the exact dynamometer scale readings.

(d) Turn the crankshaft until approximately 1000 lb-ft torque is applied to each dynamometer. Record the deflection and the exact dynamometer scale readings.

(e) Release the load, and disengage the transmission. Check the recorder zero.

(f) Shift the transmission into reverse, and record the deflection and the exact dynamometer scale readings when the crankshaft is turned to apply torques of approximately 500 and 1000 lb-ft to each of the dynamometers.

(g) From the values thus obtained, plot the pen deflections against the torque readings for coast and drive loadings. Use this graph to convert the dynamic pen deflections into lb-ft.

Note 7. If the clutch is released slowly, the torque recorder may indicate a definite amount of zero shift. This zero shift may be avoided by releasing the clutch rapidly.

5.6 Disconnect the dynamometers and the drive shaft, and record the backlash at four points (15 teeth apart).

5.7 Disassemble the test unit, and photograph the nature, extent, and location of the drive and coast contact areas on both the ring

gear and the pinion. Also record the nature and extent by which any disturbance to the ring-gear tooth faces may differ from that observed prior to the test.