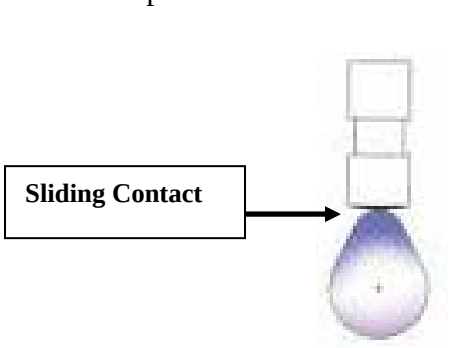
Imperial Oil

Technical Bulletin

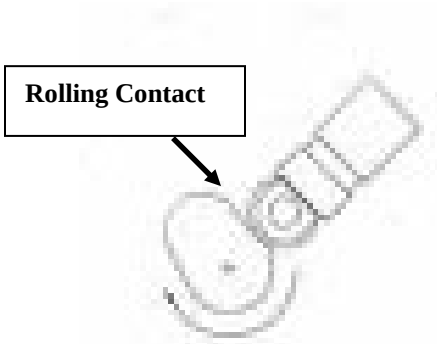
Flat Tappet Engine Wear

Passenger car engine oils use a zinc/phosphorous (ZDDP) anti-wear. Phosphorous carried through the exhaust system has a negative affect on catalytic convertor emission control performance. As part of the emission controls system, catalytic convertors are covered under warranty for 8 years / 120,000 km. To ensure converter life is acceptable, the latest generation of passenger car engine oils (API SM / ILSAC GF-4) have been formulated to 600 - 800 ppm phosphorous.

Modern passenger car gasoline engines almost exclusively use roller followers, whether cam-in-block or overhead cam valvetrain designs. Older engines use flat lifters or tappets which having a sliding, rather than rolling, contact that is much more susceptible to wear.



Flat Tappet



Roller Tappet

The oils in use at the time these engines were produced contained ~50% more ZDDP than todays oils to provide not only wear protection but some cost effective anti-oxidancy as well. Significant concern has arisen among the owners and restorers of these older vehicles over the correct lubricant selection. Data published by General Motors (SAE Paper 2004-01-2896 "How Much ZDP is Enough?", Robert M. Olree, Micheal L. McMillan) indicates that "lower levels of phosphorous, certainly as low as 0.05%, and perhaps as low as 0.03%" are sufficient to provide scuffing and wear protection for camshafts in the field.

TC (07-02): (Dave Hodgins, Chris May, Clint Smith)
For further information call our Technical Services Helpline @ 1-800-268-3183

The current API SM, ILSAC GF-4 generation of oils have a compositional limit of 600 - 800 ppm phosphorous, applying to 0W-20, 5W-20, 5W-30 and 10W-30 grades only. This exceeds the 300 - 500 ppm requirement determined in this SAE report. Other grades meeting API SM (Mobil 1 0W-40, 5W-50, 15W-50) have ~ 1000 ppm phosphorous and oils meeting API SL (Esso Extra 10W-40, 20W-50) have ~ 900 ppm phosphorous providing additional anti-wear protection.

Most of the camshaft and lifter wear in a flat tappet applications occurs at break-in and following the recommended break-in procedures is critical. OEM and aftermarket camshaft manufacturers all include, or sell separately, assembly lubes to assist in proper break-in (it should be noted that these are assembly lubes and are not intended as an in-service lubricant or an aftermarket top-treat). The first 20 - 30 minutes of operation is critical while the cam lobes and tappets "seat". Some break-in recommendations are as follows:

1. Engine assembly or break-in lube must be used on all cam lobes and lifter faces.

2. Engines should be pre-pressurized until oil can be seen at all lifters. This is typically performed be spinning the oil pump through the the distributor mounting hole using an adapter and drill. This pre-lubes the entire system prior to the engine being fired (it is not recommended to use the starter motor to perform this function).

3. In dual valve spring engines break-in should be performed using the outer springs only. When single high pressure valve springs are used lower pressure springs should be used during break-in. This will reduce loading on the lifters and camshaft during break-in.

4. After starting the engine should be varied between 1500 and 3000 rpm for 20 - 30 minutes with no engine load present.

5. Ensure pushrods are rotating which indicates the lifters are rotating as well.

6. After this break-in procedure is complete change the oil and filter.

Flat tappet break-in may be aided by a higher anti-wear concentration during the first several oil drains but once the break-in period is complete is not required for wear protection. Diesel engine oils (XD-3 Extra, Delvac 1300 Super, Delvac 1, Mobil TDT) contain higher anti-wear levels, exceed the API gasoline requirements for most of these engines, and can be used for this purpose. Once past the break-in period their use can continue though they contain much higher detergent and dispersant levels than are required for gasoline service.