



### THE NEW FIREWALL FORWARD CAMSHAFT

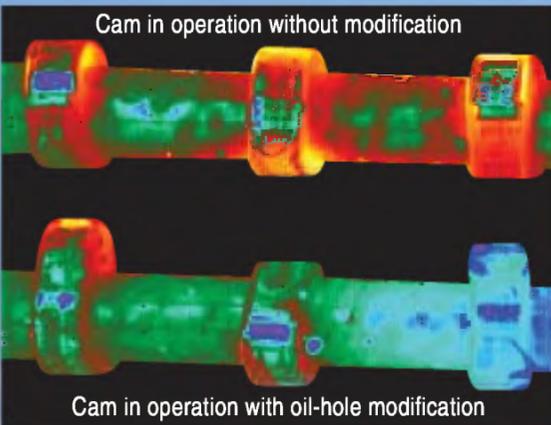
Firewall Forward has specialized in aircraft piston engine overhauls since 1977. As the company grew, it began to develop various STC modifications to enhance engine performance and reliability. The newest STC development is a modified Lycoming camshaft that provides constant oil delivery to the lifter body face and the lobe contact area. The modified camshaft was awarded FAA STC/PMA approval in February 2003, as well as US and International patent approval.

The New Firewall Forward now offers this modification to owners of Lycoming 320/360/540/541 series engines. How good is it? Each camshaft has a 4-year/100%/unlimited flight hours warranty against premature cam and lifter wear!



### IDENTIFYING THE PROBLEM

In 1995, Firewall Forward noticed an increasing number of warranty claims related to camshaft and lifter wear on Lycoming engines. To mitigate the problem, the company tried using only new camshafts in their overhauls, but the failures continued. Cam and lifter wear problems as indicated by metal in the oil filter occurred in as little as 100 hours after an overhaul on some model engines.



### INVESTIGATING THE CAUSE

In 1999, the company initiated an all out effort to determine the true cause and to solve it. Initially the problem was attributed to corrosion, types of oil, lack of additives, engine inactivity, improper warm-up or cool-down, etc. An in-depth study of "Tribology" (the science of lubrication and wear of sliding surfaces) was instrumental in understanding this premature wear issue.

First, a thermal mapping of the camshaft lobe and lifter face was performed during live engine operation. A thermal imaging camera and data acquisition system determined the actual temperatures of these surfaces at various engine speeds. The mapping and analysis revealed that the surfaces were operating at temperatures that exceeded the ability of the oil film to adequately lubricate the sliding metal surfaces. The initial factors evaluated that contributed to premature wear were:

- surface finish of the sliding surfaces,
- pressure upon the sliding surfaces (valve springs),
- velocity of the sliding surfaces (RPM),
- lubricant oxidation point (max temperature), and
- lubricant viscosity.

EGR (Exhaust Gas Recirculation) studies revealed that lead build-up in the oil was dramatically reduced with the use of low lead fuel. The sliding surfaces reached substantially higher temperatures because the lead no longer acted as an anti-scuff agent.

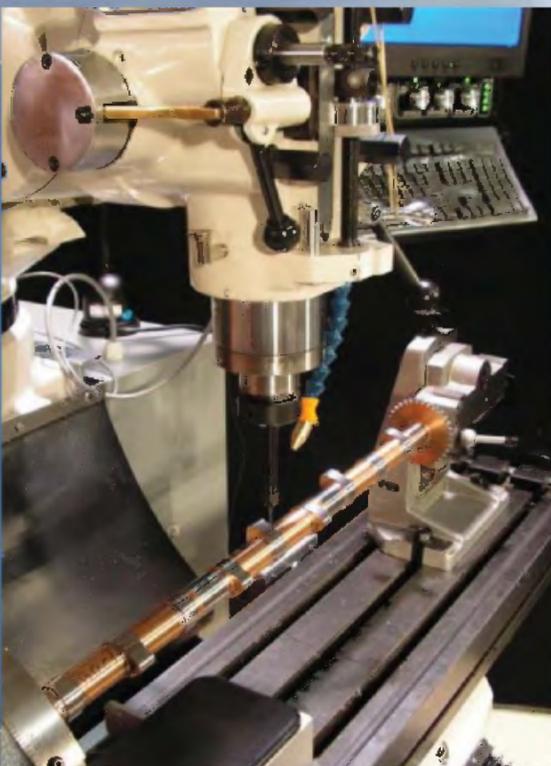
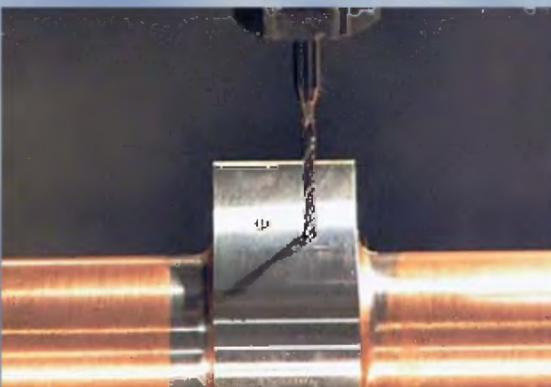
FWF also determined that there is a natural period of high temperature during engine break-in until the camshaft lobe and lifter faces "seat" together. Once the surfaces are "polished", their ability to hydrodynamically plane on a thin film of oil is greatly improved. However, if the sliding surfaces experience excessive temperatures during break-in, the surfaces will break down and begin the premature wear process.

### ENGINEERING THE SOLUTION

The solution was elegant in its simplicity: provide direct lubrication via oil holes in the camshaft lobes. This innovation is used today by the majority of engine manufacturers in the automotive and marine industries, and has effectively eliminated premature camshaft/lifter wear.

Firewall Forward tested the feasibility of this solution on Lycoming engines. Because all Lycoming camshafts are hollow, oil could be introduced into the interior of the camshaft. With both ends of the camshaft blocked, the oil enters through holes drilled into the camshaft bearing journals, and then exits through precisely drilled holes at critical points on the camshaft lobes and directly onto the lobe ramp area. Thermal imaging once more provided the necessary data for the exact size and location of the oiling holes.

The perfected solution achieved a substantial decrease in operating surface temperatures with a corresponding increase in hydrodynamic planing between the sliding surfaces. Over 200 engines operating with modified camshafts in a four year period have confirmed the success of the modification. The effectiveness of the modification allows The New Firewall Forward to offer this exceptional warranty to our modified camshaft customers: four year/100% warranty with unlimited flight hours.



### PERFORMANCE THROUGH TECHNOLOGY AND INNOVATION

