The Guy Who Put the Gearbox Up Front

Charles Schultz, chief engineer, Beyta Gear Service and *Gear Technology* technical editor and blogger

As the Indianapolis 500 begins its second hundred years, it is a good opportunity to recall the guy who put the gearbox "up front." Harry Arminius Miller, native of Menomonie, Wisconsin, lead a team of engineers, designers, and craftsmen that created winning equipment for the Greatest Spectacle in Racing. From humble beginnings as a mechanic in a lumber yard, he rose to the top levels of motorsport by building finely crafted machinery.

His first breakthrough was in carburetors, and booming sales allowed him to build a well-equipped machine shop before The Great War. An extensive re-build on a Peugeot racing engine led to more custom engines for auto, boat, and even aircraft use.

A custom-built Miller engine sold for the princely sum of $4,000 in 1916 (approx. $96,000 in 2017 dollars). It was completed in less than seven months — seven months from starting the drawings to delivery, including pattern making, casting aluminum parts, machining, assembly, and dynamometer testing; an unheard of performance then and now.

Not content to just supply engines, Miller and his company were soon building complete racing cars for the most famous drivers in the country. The early 1920s saw Miller and Duesenberg battle for supremacy at Indianapolis and races around the country. Always looking for an edge, Miller saw an opportunity to lower the car's center of gravity by eliminating the driveshaft and sending power to the front wheels. The seat bottom was nine inches closer to the ground — a significant change, even with a very light driver. Front wheel drive was not a new idea, Walter Christy had built a monstrously huge racer for Barney Oldfield in the early days of the sport that even featured a transversely mounted engine like today's passenger cars.

Miller chose to simply turn his compact supercharged 91-cubic-inch, straight-eight around and connect it to a custom-built transmission that also served as part of the chassis. It evolved over a period of years to have inboard drum brakes, a semi-independent de Dion axle, and the latest in universal joint technology. As with all Miller Engineering products, the front drive unit was "finished all over," as befit the "jewelry on wheels" reputation Miller enjoyed.

Happily for gear enthusiasts, many of the Miller racing cars have been restored and, surprisingly, the detail drawings of many components have also survived. Longtime Miller collaborator Leo Goosen was active in racing into the 1980s and he kept track of his prints.

So just how good was the Miller FWD unit? With the assistance of G. E. White, auto racing consultant to the Smithsonian Institution, we obtained detail drawings of the reduction gears of the 1929 version of the Miller front drive gearbox. The photograph is from Mr. White's 2004 book, *The Marvelous Mechanical Designs of Harry A. Miller*. If you look closely you can see that the gear teeth are badly damaged after just 91 laps at The Brickyard. While the car exited the event due to an engine problem, these gears do not look long for the world.

According to the drawings, they were made of SAE #6145 steel with a "desired carbon" of "45 to 50". The teeth are Fellows 6/8 NDP with a 20 degree pressure. If you trace the power flow through the transmission, you see that the shiftable gears are on the low-speed/high-torque side of the device. The generously sized [10" pitch diameter] bevel set has a 3:1 ratio; a 1.1 ratio spur set transfers the power to the shifter gears. The supercharged 91 developed as much as 154 horsepower at 7,000 rpm; 103 horsepower-per-liter is still an impressive number today.

Modern gear rating calculations reveal the cause of the pictured tooth flank damage: contact stresses are as high as 490,000 psi and bending stresses approach 170,000 psi on the most heavily distressed component. The carburized bevel set's stresses are well within current values, perhaps reflective of the rapid advances the auto industry was making with rear axles. Some current open wheel race cars use bevel gears based on 1928 Ford Model A geometry.

Modern Indy cars use a highly developed, transversely mounted transaxle but, unlike the Miller design, the shiftable gears are located on the high-speed end of the system. Peak stresses might approach the levels Miller experienced, but the gears are now carburized, hardened, ground, shotpeened and superfinished. Race retirements for gear failure are infrequent because of these improvements.