HOTSEAT

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How to perfectly heat treat the gear that is smaller, thinner, finer pitch, with a ton of residual stress from machining and the ability to satisfy the cost constraints of a commercial or OEM heat treat has been the topic of conversation around the world.

THREE ON THE TREE; FOUR-ON-THE-FLOOR; FOUR SPEED AUTOMATIC; five speed manual; six speed automatic; six speed manual; seven, eight, and nine speed automatic…where will the drive for the maximum number gears in an automobile transmission end? The drive for fuel economy seems to have no limits. Is there a 16-speed transmission on the drawing board like heavy hauler trucks use? Maybe the CVT transmission will make a major comeback. It's used sparingly in some Japanese cars, but it seems to have limited use where higher horsepower is involved.

The drive to improve gas mileage for automobiles started in earnest after the government, primarily California, began mandating air quality standards to reduce smog-causing exhaust gases and other hydrocarbon emissions. The catalytic converter played a key role here by incorporating the platinum catalyst into the exhaust system. This forced the introduction of unleaded fuels because lead reactions in the combustion process would coat and disable the converter. In addition, engines were designed to run richer, killing mileage, and cooler, reducing the formation of NOx — oxides of nitrogen created when combustion temperatures increase. All of this apparatus is why you can't see the pavement when you look under the hood of today's automobiles. Before all of this development, you could drop a wrench under the hood and pick it up under the car. Now the wrench gets lost in the jungle of wires, hoses, canisters, filters, belts, and any number of unidentifiable widgets.

The driving public began realizing that their fuel usage was skyrocketing because of these innovations; the ordinary sedan averaged maybe 14 MPG, forcing auto makers to begin thinking about ways to improve mileage. It seems few people at the time realized that the kids racing at Detroit Drag-Way, tuning an engine for maximum performance, also improved gas mileage. My 1961 "unsafe-at-any-speed", 98 HP, Positraction, four-on-the-floor Corvair Monza coupe could do the ¼ mile in the white-knuckle time of 16.99 seconds at 86 miles per hour. That car engine could not have been blue-printed and get better mileage; I'd routinely get 20 MPG in town and 32 at highway speeds. And due to the severe front/back rear engine weight ratio, it could do a "wheelie" off the line in the process; not a big one mind you, but still impressive for a stock car. Eventually the development of transistors, rudimentary computers, and finally microprocessors and fuel injection enabled this emerging technology to dominate the mileage standards we enjoy today.

After it was thought that all that could be done to an engine to improve mileage was done, the transmission became the target for improving gas mileage. Manual transmission gears had to be tough in the 60's. The mettle of a drag racer, even this Sunday afternoon A. J. Foyt, was measured by your ability to keep your foot on the accelerator while shifting, hoping you wouldn't miss a gear and see the crowd laugh and point fingers at that amateur.

Unknown at the time, and launching the evolution of the performance automatic transmission, Chrysler was developing the push-button TorqueFlite automatic transmission. This automatic gearbox allowed racers to electronically control the shifting function to outperform manual transmissions of the 409 Chevys and big block Fords; I believe this inspired the race for more efficient transmission systems.

Fast-forward to the 21st century: Computer-controlled ignition timing, fuel injection, exhaust analysis, and engine torque matching to transmission shift sequences have led to smaller, lighter transmissions with many more gears. Now add fuel-saving wind tunnel aerodynamic studies to find low drag coefficients and the transmission with all of those gears must be whisper quiet…and that always brings us back to heat treating.

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The transmission or gear OEM will generally specify what heat treat process will be approved to satisfy noise (distortion), case depth, and hardness requirements. Material will dictate which of the available processes is most suitable, carburizing [endo or LPC], induction, neutral hardening, or nitriding.

Neutral hardening generally is not applicable since the teeth must be hardened for wear; thus, a 60+ HRC is required. Then the entire gear mass would have the same higher carbon and alloy, not just the teeth, creating excessive and unnecessary cost.

Induction can work, but, again, the entire gear would have the higher alloy, not just the teeth. Induction is a possibility, because the gear can be rotated during heating and quenching, providing improved distortion control.

Nitriding, for its very low and consistent distortion, is gaining acceptance again due to improved control over (or, better yet, elimination of) white layer, but it too requires a higher alloy to maintain the core hardness at nitriding temperatures.

And that leaves carburizing followed by quenching: Since general purpose or family car transmissions are not subject to very high loading and fatigue, IGO is not an issue, making LPC an overkill. As I've discussed before, quenching is the primary issue. We have the ability to control distortion, but at what cost?

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