LOCK-UP TORQUE CONVERTER SECRETS

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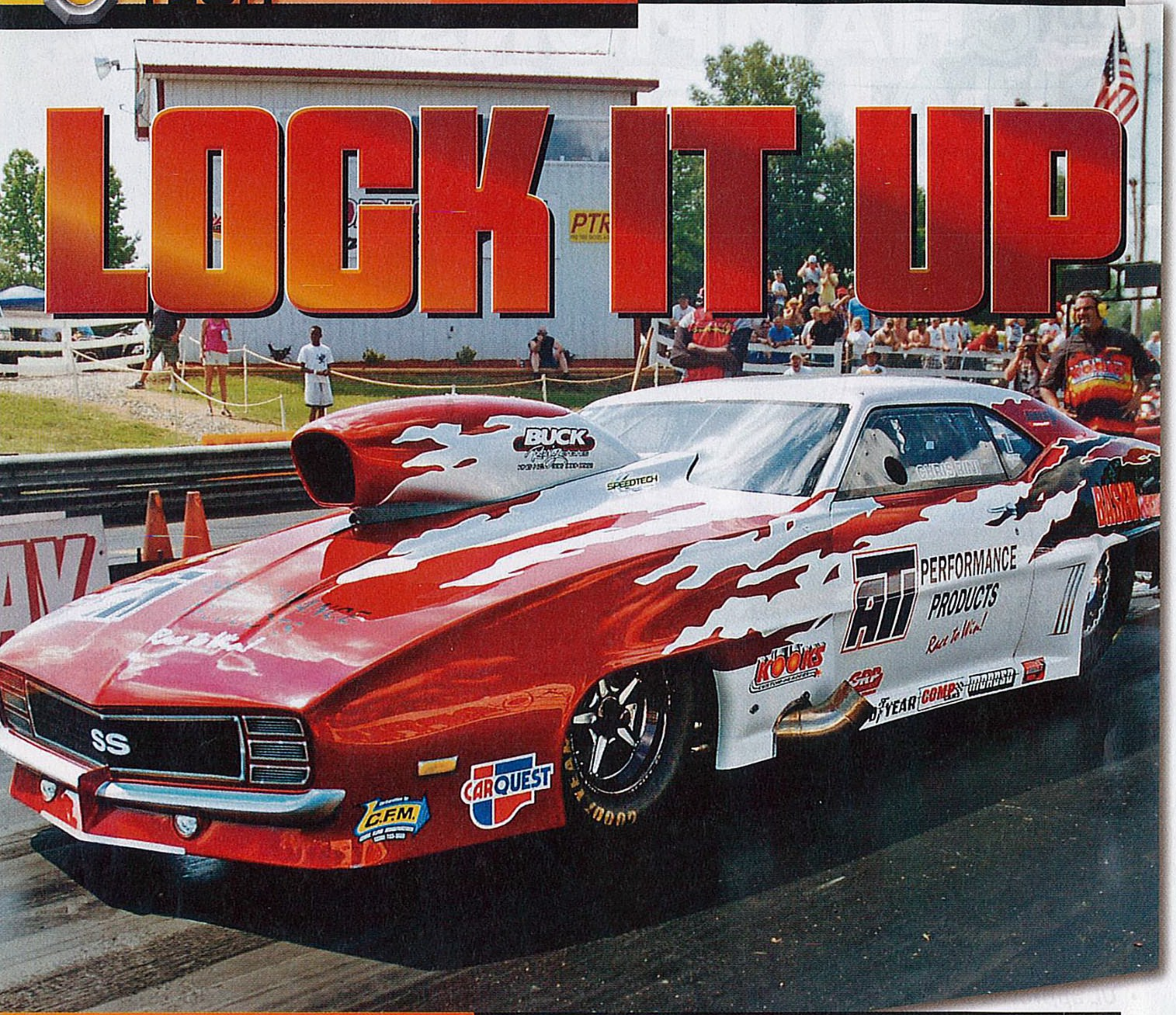


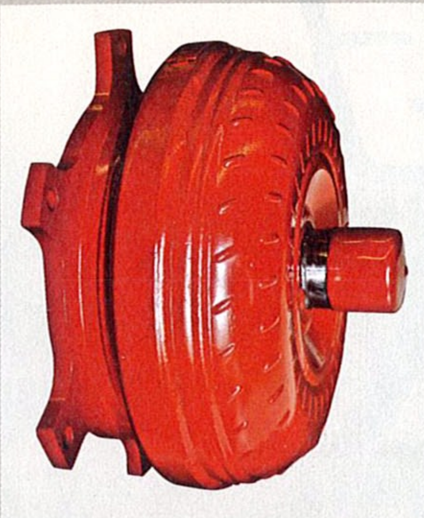
Lock-Up Torque Converters Are Making A Comeback

BY JOHN DiBARTOLOMEO

While automatic transmissions in racing have come a long way, there is still no way that a torque converter can ever compete with a clutch. Let's face it, clutches are locked tight to the engine's rpm, while a torque converter has a certain amount of slippage. That slippage can lead to an inefficiency that has plagued converters since day one and probably will forever, although today's converter manufacturers have designed their units to be as efficient as possible.

Because of its design, a torque converter can never reach 100-percent lock-up. A converter is nothing more than fluid coupling that uses oil flow to drive the input shaft of the transmission which is connected to the turbine inside the converter. The turbine is not physically connected to anything

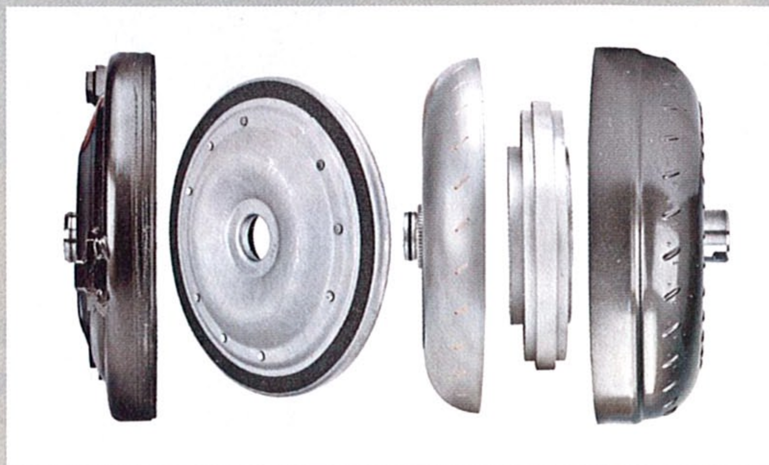
Each year, thousands of race converters are welded together to shipped in much the same fashion they've always been. Now, there's a whole new design that's taken the tracks by storm, but only if you have enough power to handle it.



Lock-up torque converters are not a new concept, even to drag racing, but they're making a comeback.

In classes where racers have the necessary horsepower, lock-up converters are bridging the gap allowing race cars to leave the starting line soft with a converter but lock-up at the finish line like a clutch car would.

Lock-up converters in OEM automobiles utilize a clutch disc which seats to lock the converter's turbine to the output shaft.



This exploded view shows how the clutch plate is splined to the turbine in an OEM converter. Race versions are totally different as they have to harness *just a little more horsepower* than a street car.

other than the input shaft and by itself is spinning free inside the converter housing. Through a series of vanes, oil flows through the converter and pushes on those vanes to spin the turbine. When the turbine spins, it drives the input shaft and thereby causes the car to move.

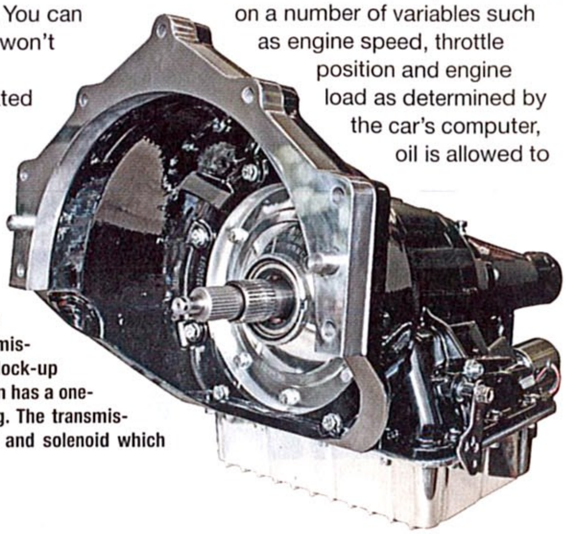
The opposite of this is the clutch, where the transmission's input shaft is connected to the clutch disc. Once the clutch in engaged, a pressure plate pushes against the clutch disc to lock that disc to the engine's flywheel. The result? Instant 1:1 transmission lock-up.

Over the years, Detroit (and we use that term loosely to describe the factories, albeit a lot of manufacturing does take place overseas) has come up with lock-up torque converters in an effort to increase converter efficiency as a way to increase fuel mileage. It's certainly not a new concept as the Packard Motor Car Company, which no longer produces automobiles, used the lock-up principle on their Ultramatic transmissions in the late '40s and early '50s before it was discontinued. Present-day manufacturers looked again to the lock-up design in the '70s as fuel efficiency began to become prominent.

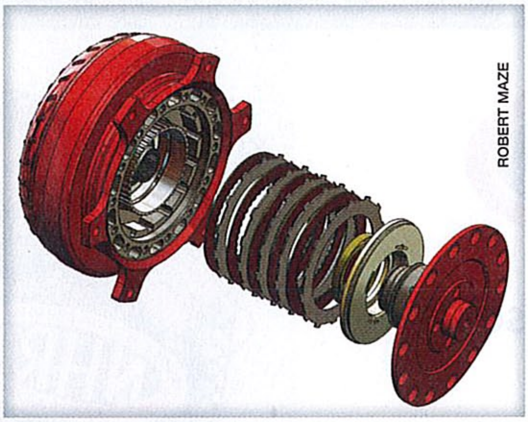
Which brings us back to race converters. Jim Beattie of ATI Performance said, "Most torque converters will usually slip roughly four to five percent at the finish line due to their internal oil flow. You can get one to lock up tighter, but it won't leave the starting line as well."

Lock-up designs have populated the landscape of drag racing years ago, but for one reason or another, never really took off. Today is different, though. First, we need to explain how a lock-up works.

In Detroit's case, a clutch assembly is mounted in front of the turbine. The front of the turbine is splined to a clutch plate. Under normal conditions, a certain amount of oil pressure exists on the front side of the turbine which keeps the clutch plate from locking up to the converter's front cover. At a certain point based on a number of variables such as engine speed, throttle position and engine load as determined by the car's computer, oil is allowed to

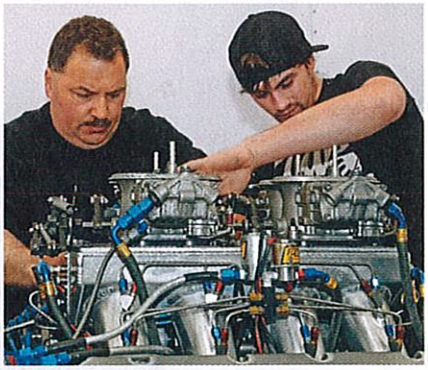


The lock-up converter must be used in conjunction with a corresponding transmission. Because of the extra length of the lock-up portion of the converter, the transmission has a one-inch extension added to the bellhousing. The transmission also utilizes a special input shaft and solenoid which feeds oil to lock the converter.



ROBERT MAZE

While an OEM lock-up converter is locked all the time and disengaged at times when the vehicle's computer says so, a race lock-up unit is disengaged so the converter works as it is designed. At a point down track determined by either rpm or time, oil flows to lock up the clutch pack. You can also see here how the lock-up section adds length to the converter.



Part of the reason for lock-up converters not working in the past was the crew chiefs needing to know what to do when the converter went to lock up. When that happens, it pulls the engine rpm down quite hard at which time power needs to be applied either through nitrous or other means.

evacuate from that area, essentially locking up the converter. The large diameter of a stock converter, enabled only one clutch plate to be effective, living in applications with horsepower levels quite a bit less than a race engine.

In the mid-'90s, Bob Maze, then owner of Transmission Specialties, had the idea for a lock-up converter for race applications. "I was involved with Steve Kirk and Bob Reiger with some fast heads-up race cars," Maze said, "and they were getting killed by the clutch cars. I had been thinking about a lock-up design for years but it required quite a bit of work and money."

The money soon came and Maze went about building several lock-up converters, albeit with quite a different design than Detroit's. The smaller diameter race converter meant that a single clutch disc would not have enough surface area to stay properly locked up with no slippage.

"We actually redesigned the front cover of the converter and the turbine to accept a multiple clutch pack and piston assembly." Maze said. "We then added a second circuit to the transmission front pump and input shaft. Under normal conditions, the converter would remain and work just as it always would. However, at a predetermined time, oil would flow through the input shaft to the front clutch pack, locking the turbine to the front cover and essentially locking up the converter."

As we had asked earlier, the end result? Using basically a Powerglide transmission, once the car had completed its 1-2 shift, the converter would lock and sound as if it made another shift. The "predetermined time" was set to occur by an rpm timer to happen after the car passed the half-track point. No more four-five percent slippage and immediately Kirk and Reiger were able to compete and defeat more than their share of racers.

There remained two distinct downsides to the design, though. First, when the converter locked up, it loaded the engine and pulled the rpm down quite a bit, especially in a heavier car. If the engine didn't have enough horsepower, torque and cubic inches (i.e. power) to drive through that point, elapsed time suffered. This was the case of earlier lock-up designs used in lower horsepower applications, and possibly part of the reason for them not working.

The other problem involved cost. Maze said, "The design required not only a new converter, but the transmission had to be modified to apply the lock-up section of the converter. It all added to a bunch of design and machining."

Eventually, Maze sold his interests in Transmission Specialties and entered the world of computer-aided design (CAD) software. This includes not only the design software but several flow testing and modeling programs as well.

In late 2009 ATI introduced a lock-up converter of its own enabling Chris Rini to compete with the clutch cars on the back-half of the race track in NMCA Pro Street competition. Rini went on to win the Pro Street NMCA championship and set the standards for elapsed time and mph in the class. All with a Superglide 4 and ATI lock-up converter. Beattie said, "While most of the guys in that class were switching over to clutches, Rini was still able to run with those guys using one of our Superglide transmissions. But we needed something more and the lock-up idea was just the next generation."

As longtime friends, Jim Hughes of Hughes Performance and Maze had always discussed product design. It was Maze, as well as Jim's brother Jeff, who created the company's XP4 transmission designed to last in even the most powerful classes of drag racing.

As mentioned earlier, with the use of a 2-speed transmission, the lock-up offers what sounds exactly like a third shift while enabling converter slippage to drop to zero. There is absolutely no slippage.

Today, both ATI and Hughes offer a lock-up torque converter using the same basic principles as in the past albeit totally different from earlier designs. What makes them operate efficiently today when they didn't work as well in the past is horsepower. Today's race engines operate at a higher rpm and with a much broader power band. When lock-up occurs, as we mentioned previously, it has a tendency to pull the engine rpm down low enough whereby a lower horsepower powerplant would not be able to recover.

Hughes said, "Installing a lock-up converter all by itself will not guarantee any success. You have to know what to do when the engine goes to lock-up. It pulls the engine rpm down quite a bit and therefore you have to be prepared to throw some extra horsepower into the mix at that point."

In addition to all of this, the use of flow modeling and the testing equipment available today has enabled both ATI and Hughes to produce a quality component that can be held to extremely tight tolerances, tolerances that 15-20 years ago were unheard of.

ATI Performance's lock-up version utilizes an aluminum front housing to help cut down on weight.

Beattie said, "We have 29 CNC machining centers in our facility and each one runs continually to produce quality components. We also have a torque converter dyno in-house that was previously owned by General Motors which allows us to test our designs and ideas before a single product ever makes it in a race car."

In addition to their own converter and transmission dyno, Hughes uses their own Hughes Motorsports race team for invaluable on-track testing. They recently installed one of their lock-up converters and transmissions in one of their Super Comp dragsters just to see how it performed. The effort produced no benefit, but it did allow them the ability to get a first-hand look at exactly what happens to the engine rpm and wheel speed when the converter locks up.

The cost concept also comes into play. However, once you add up the cost of a stick-shift transmission, bellhousing and clutch assembly along with the continual maintenance it requires, the cost of a specially built transmission and converter is comparable. All without the continual maintenance a clutch requires. DRA

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