Torque Converter Operation Explained

The torque converter is one of the least understood components in an automatic transmission equipped vehicle. I will attempt to explain what it does and how it does it.

The torque converter has a few different functions.

We first need to understand that there is no direct link between the crankshaft and the transmission input shaft (except in the case of a lock up style converter, but we'll talk about that later). This means that the first function of the converter is to connect the crankshaft and the input shaft so the engine can move the vehicle; this is accomplished through the utilization of a fluidic coupling effect.

The torque converter also replaces the clutch that is required in a manual transmission; this is how an automatic transmission vehicle can come to a stop while still being in gear without stalling the engine.

The torque converter also acts as a torque multiplier, or extra gear ratio, to help the car get moving from a stop. In modern day converters this theoretical ratio is anywhere between 2:1 and 3:1.

Torque converters consist of 4 major components that we need to concern ourselves with for the purpose of explanation.

The first component, which is the driving member, is called the impeller or "pump". It is connected directly to the inside of the converter housing and because the converter is bolted to the flexplate, it is turning anytime that the engine rotates.

The next component, which is the output or driven member, is called the turbine. The transmission's input shaft is splined to it. The turbine is not physically connected to the to the converter housing and can rotate completely independently of it.

The third component is the stator assembly; its function is to redirect the flow of fluid between the impeller and the turbine, which gives the torque multiplication effect from a standstill.

The final component is the lock up clutch. At highway speeds this clutch can be applied and will provide a direct mechanical link between the crankshaft and input shaft, which will result in 100% efficiency between the engine and transmission. The application of this clutch is usually controlled by the vehicle's computer activating a solenoid in the transmission.

Here's how it all works. For the sake of simplicity, I will use the common analogy of two fans which represent the impeller and the turbine. Let's say that we have two fans facing each other and we turn only one of them on- the other fan will soon begin to move.

The first fan, which is powered, can be thought of as the impeller that is connected to the converter housing. The second fan- the "driven" fan can be likened to the turbine, which has the input shaft splined to it. If you were to hold the non-powered fan (the turbine) the powered one (the impeller) would still be able to move- this explains how you can pull to a stop without the engine stalling.

Now imagine a third component placed in between the two, which would serve to alter the airflow and cause the powered fan to be able to drive the non-powered fan with a reduction of speed- but also with an increase of force (torque). This is essentially what the stator does.

At a certain point (usually around 30-40 mph), the same speed can be reached between impeller and the turbine (our two fans). The stator, which is attached to a one way clutch, will now begin to turn in conjunction with the other two components and around 90% efficiency between the crank and the input shaft can be achieved.
The remaining 10% slippage between the engine and transmission can be eliminated by connecting the input shaft to the crankshaft through the application of the lock up clutch that was mentioned before. This will tend to lug the engine, so the computer will only command this in higher gears and at highway speeds when there is very little engine load present. The main function of this clutch is to increase fuel efficiency and reduce the amount of heat that is generated by the torque converter.

Another term that may be unfamiliar is that of a “high stall” torque converter. A high stall converter differs from a stock converter in the sense that the rpm is raised at which the internal converter components- the impeller, the stator and the turbine start to turn together, and hence, stop the torque multiplication phase and begin the coupling phase. The point at which engine rpm will stop climbing with the drive wheels held stationary and the throttle fully opened is referred to as “stall speed”.

The idea behind a higher stall torque converter is to allow the engine to rev more freely up to the point where the powerband begins, and therefore, enable the vehicle to accelerate from a stop under more power.

This becomes increasingly important when an engine is modified. Engine modifications such as ported heads, bigger cams, bigger turbos (in some cases), bigger intakes, etc. tend to raise the point where the powerband begins. For best performance, the stall speed needs to be raised accordingly to work optimally in conjunction with the given vehicle alterations.

In simple terms, for best performance, the stall speed should be raised at least to the point where the torque curve is heading towards its peak. As a rule of thumb, the stall speed should be set to match the rpm at which the engine is making at least 80% of its peak torque for a street driven vehicle.

As you can imagine, a vehicle that can accelerate from a stop with 80% of its peak torque will easily outperform an otherwise identical vehicle that can only launch at 50% of its available torque.

For a performance or ”high stall” torque converter to produce maximum gains, it needs to be configured to the specific vehicle in which it will be installed.

Factors such as engine torque and the rpm at which it is greatest, differential gear ratio, vehicle weight, camshaft design, compression ratio, type of induction- forced or naturally aspirated, and a host of other variables all need to be taken into consideration. Be aware that the “off the shelf” type performance torque converters sold by some manufacturers are very unlikely to be optimized for all vehicles and their unique requirements.

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About the Author

John Lombardo is owner of IPT Performance Transmissions- http://www.importperformancetrans.com The Company is noted not only for drag race and street performance automatics but also for having drivetrain products not available elsewhere for non-traditional applications, especially import, sport compact, and late model vehicles. John has over 20 years of experience in the transmission and automotive repair industry with a focus on the high performance and racing automatic transmission aspect of the business. John possesses numerous certifications and awards from ASE (Automotive Service Excellence), ATRA (The Automatic Transmission Rebuilder's Association), ATSG (The Automatic Transmission Service Group) and is a Certified Master Transmission Technician.