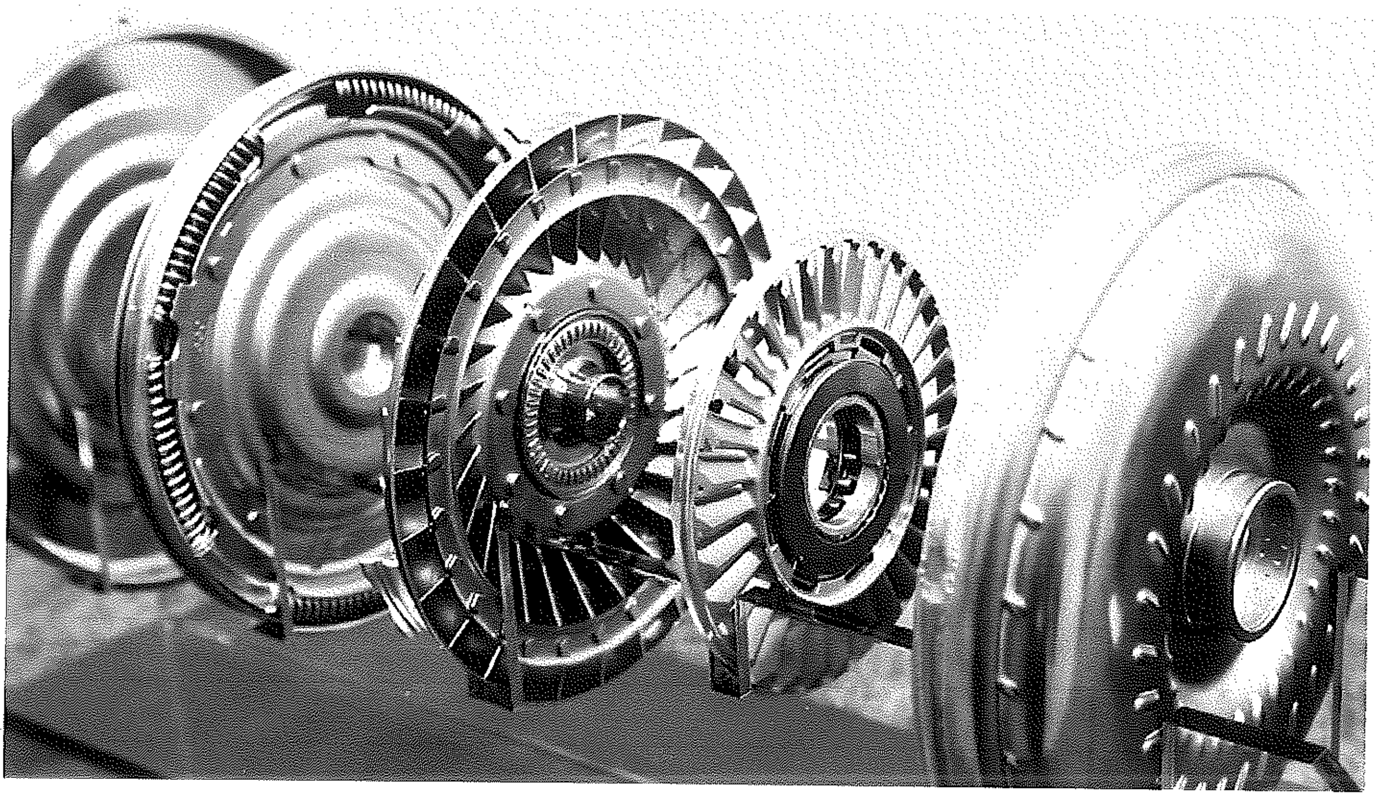
BRIEF UNDERSTANDING

How Torque Converters Work

By: Karim Nice & Talon Homer | Updated: Jan 26, 2023



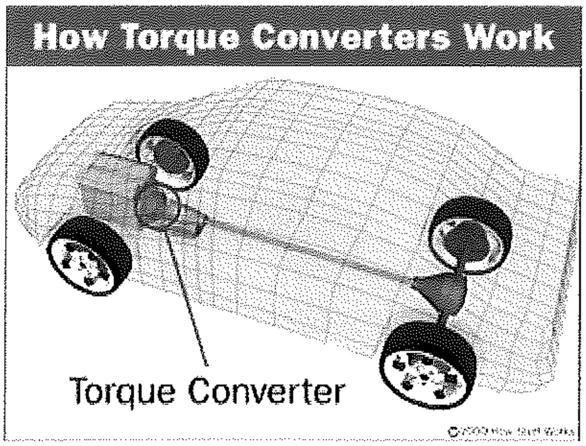
A variety of torque converters are shown. Cars with automatic transmissions use a device called a torque converter to allow the engine to keep running as the wheels come to a stop.
DREAMNIKON/SHUTTERSTOCK

If you're familiar with manual transmissions, you know that an engine is connected to a transmission by way of a clutch. Without this connection, a car would not be able to come to a complete stop without killing the engine. Cars with automatic transmissions have no clutch that disconnects the transmission from the engine. Instead, they use a device called a **torque converter**. It may not look like much, but there are some very interesting things going on inside.

Turning a car's engine crankshaft produces torque (which is the energy you create by twisting something). Torque is what allows you to accelerate your car. The more torque an engine produces, the faster a car goes. A torque converter allows the engine in a car with an automatic transmission to keep running even as the wheels come to a stop.

In this article, we'll learn why automatic transmission cars need a torque converter, how a torque converter works as well as some of its benefits and shortcomings. The automatic gearboxes we refer to are the traditional type that have been popular in cars since about the 1950s. Newer types of automated transmission, like the semi-manual gearbox and CVT use other methods of power delivery, and don't include torque converters.

Torque Converter Basics

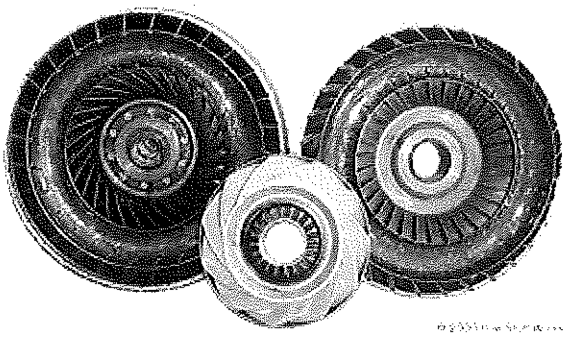


The torque converter is situated between the engine and the transmission.
HOWSTUFFWORKS

A torque converter is a type of fluid coupling, which allows the engine to spin somewhat independently of the transmission. If the engine is turning slowly, such as when the car is idling at a stoplight, the amount of torque passed through the torque converter is very small, so keeping the car still requires only a light pressure on the brake pedal.

If you were to step on the gas pedal while the car is stopped, you would have to press harder on the brake to keep the car from moving. This is because when you step on the gas, the engine speeds up and pumps more fluid into the torque converter, causing more torque to be transmitted to the wheels.

Inside a Torque Converter

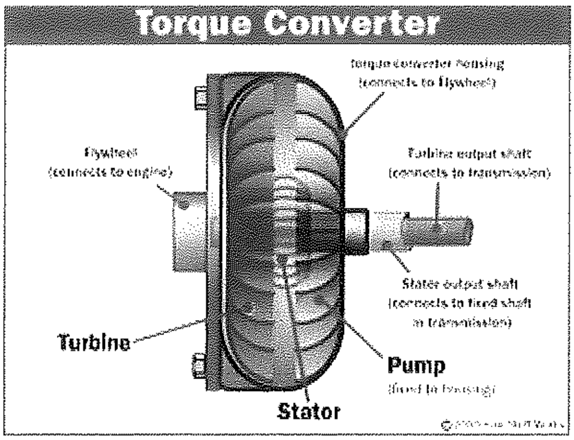


Three parts of a torque converter are (left to right): the turbine, stator and impeller (pump).
HOWSTUFFWORKS

There are four components inside the very strong housing of the torque converter:

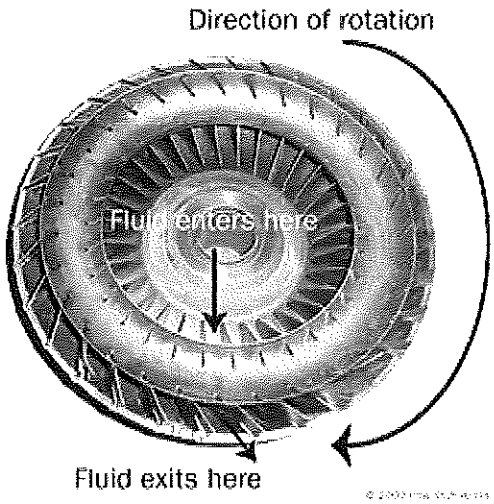
- impeller
- turbine
- stator
- transmission fluid

The housing of the torque converter is bolted to the flywheel of the engine, so it turns at whatever speed the engine is running at. The fins that make up the pump of the torque converter are attached to the housing, so they also turn at the same speed as the engine. The cutaway below shows how everything is connected inside the torque converter.



This illustration shows how the parts of the torque converter connect to the transmission and engine.
HOWSTUFFWORKS

The **impeller** inside a torque converter is a type of centrifugal pump. As it spins, fluid is flung to the outside, much as the spin cycle of a washing machine flings water and clothes to the outside of the wash tub. As fluid is flung to the outside, a vacuum is created that draws more fluid in at the center.



The pump section of the torque converter is attached to the housing.
HOWSTUFFWORKS

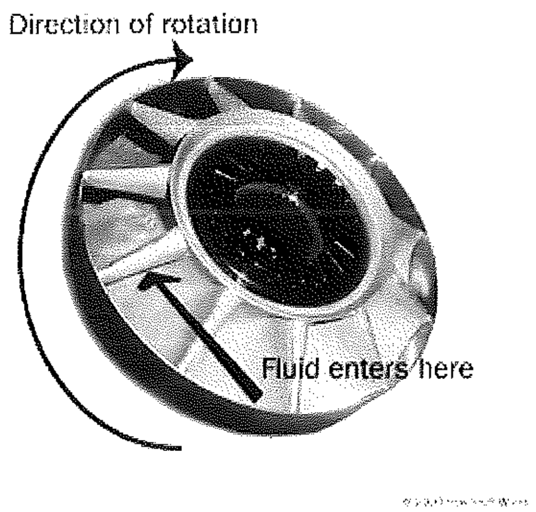
The fluid then enters the blades of the **turbine**, which is connected to the transmission. The turbine causes the transmission to spin, sending power through shafts, differentials, and out to the driving wheels. You can see in the graphic at left that the blades of the turbine are curved. This means that the fluid, which enters the turbine from the outside, has to change direction before it exits the center of the turbine. It is this directional change that causes the turbine to spin.

In order to change the direction of a moving object, you must apply a force to that object — it doesn't matter if the object is a car or a drop of fluid. And whatever applies the force that causes the object to turn must also feel that force, but in the opposite direction. So, as the turbine causes the fluid to change direction, the fluid causes the turbine to spin.

The fluid exits the turbine at the center, moving in a different direction than when it entered. The fluid exits the turbine moving opposite the direction that the pump (and engine) are turning. If the fluid were allowed to hit the pump, it would slow the engine down, wasting power. This is why a torque converter has a **stator**.

We'll take a closer look at the stator in the next section.

The Stator



The stator sends the fluid returning from the turbine to the pump. This improves the efficiency of the torque converter. Note the spline, which is connected to a one-way clutch inside the stator.
HOWSTUFFWORKS

The stator resides in the very center of the torque converter. Its job is to redirect the fluid returning from the turbine before it hits the pump again. This dramatically increases the efficiency of the torque converter.

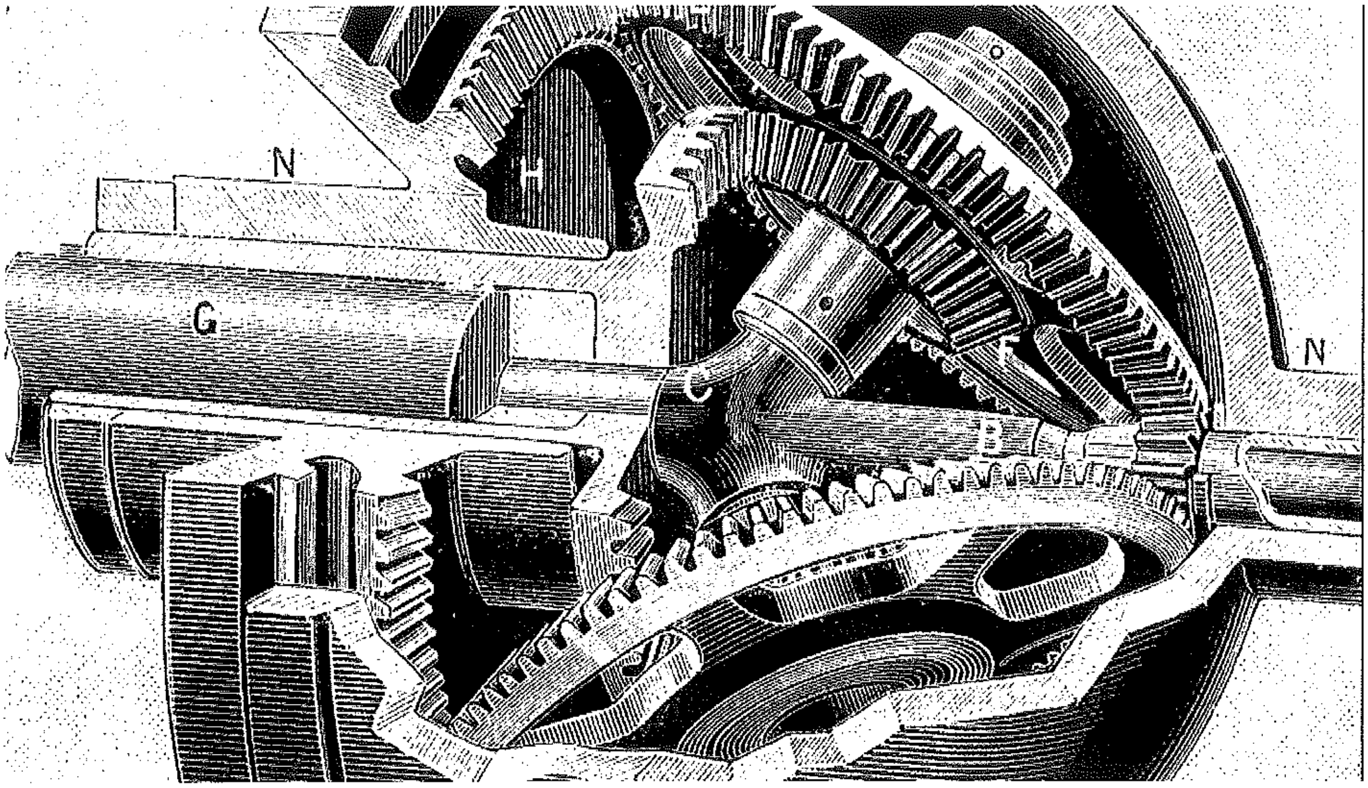
The stator has a very aggressive blade design that almost completely reverses the direction of the fluid. A one-way clutch (inside the stator) connects the stator to a fixed shaft in the transmission (the direction that the clutch allows the stator to spin is noted in the figure above). Because of this arrangement, the stator cannot spin with the fluid — it can spin only in the opposite direction, forcing the fluid to change direction as it hits the stator blades.

Something a little bit tricky happens when the car gets moving. At highway speed, both the impeller and the turbine are spinning at almost the same rate (the pump always spins slightly faster). At this point, the fluid returns from the turbine, entering the pump already moving in the same direction as the pump, so the stator is not needed.

Even though the turbine changes the direction of the fluid and flings it out the back, the fluid still ends up moving in the direction that the turbine is spinning because the turbine is spinning faster in one direction than the fluid is being pumped in the other direction. If you were standing in the back of a pickup moving at 60 mph (96 kph), and you threw a ball out the back of that pickup at 40 mph (64 kph), the ball would still be going forward at 20 mph (32 kph). This is similar to what happens in the turbine: The fluid is being flung out the back in one direction, but not as fast as it was going to start with in the other direction.

At these speeds, the fluid actually strikes the *back* sides of the stator blades, causing the stator to freewheel on its one-way clutch so it doesn't hinder the fluid moving through it.

Benefits and Weak Points of Torque Converters



Antique illustration of adaptor transmission gearbox. ILBUSCA / GETTY IMAGES

In addition to the very important job of allowing your car to come to a complete stop without stalling the engine, the torque converter actually gives your car more torque when you accelerate out of a stop. Modern torque converters can multiply the torque of the engine by two to three times. This effect only happens when the engine is turning much faster than the transmission.

In some performance applications, cars will have installed what's called a high-stall torque converter. Compared to a normal street converter, this component will send power to the wheels at a much higher RPM (revolutions per minute). This means that the torque multiplicative effect of the converter happens when the engine is making close to its peak power, allowing it to accelerate hard off the line. However, this effect is not desirable in day-to-day traffic.

At higher speeds, the transmission spins at about 90 percent of the engine speed. Ideally, though, the transmission would move at *exactly* the same speed as the engine, because this difference in speed wastes power and causes the assembly to shed heat. This is part of the reason why cars with automatic transmissions sometimes get worse gas mileage than cars with manual transmissions.

To counter this effect, some cars have a torque converter with a lockup clutch. When the two halves of the torque converter get up to speed, this clutch locks them together, ensuring that the engine and gearbox spin at the same speed and minimizing power loss. Many modern automatics have also added up to 10 forward gears in order to optimize power delivery and match the efficiency of older manual designs.

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