Principle of Operation

Product Name: Hydraulic Starter
Date: April, 2013

The Kocsis Technologies, Inc. hydraulic starter commonly known as the Hydrotor® operates as a means of dependable sparkless engine starting. The Hydrotor® models as shown below are available in various sizes with various outputs. Dependent upon the size of the engine and any parasitic load during starting, the model selected will be suited to provide fast, safe, reliable starting.

Model	Torque (@3000psi)	Max Pressure	Max Speed	HP
A Series	15 ft-lbs (20.3 N-m)	3000 psi (206 bar)	7000 RPM	20
B Series	42 ft-lbs (56.9 N-m)	3000 psi (206 bar)	7000 RPM	56
C Series	72 ft-lbs (97.6 N-m)	3000 psi (206 bar)	4500 RPM	62
D Series	120 ft-lbs (162.7 N-m)	3000 psi (206 bar)	4500 RPM	103
E Series	200 ft-lbs (271.1 N-m)	3000 psi (206 bar)	3000 RPM	114

The hydraulic starter in general terms has two main parts. One side of the starter called the motor housing contains the “wet” side becuase it is filled with hydraulic fluid during normal operation. The other side is considered the “dry” side. This side contains the drive mechanism and pinion housing. The two sides are seperated by a highly engineered rotary shaft seal which is designed to keep the fluid from escaping the motor housing as well as keep any dust or contaminates from the flywheel housing out of the hydraulic motor.

The motor housing of the starter is formally classified as a fixed displacement hydraulic motor. Figure 1 below shows the internals of the motor of a B Series starter. As you can see, the hydraulic motor is made up of a barrel which contains pistons. The hollow pistons are driven by hydraulic fluid provided by either an accumulator or hydraulic pump. For ease of viewing in Figure 1, the barrel has been made semi-transparent. The pistons advance linearly to ride against a ruggedly designed angle bearing. It is this interface between these parts that causes the rotation of the starter. As the piston cavities on the inlet side of the motor are being filled with hydraulic fluid, those on the outlet side are being emptied to tank. The flow and pressure of the fluid provided to the hydraulic starter is translated into torque and speed. As flow increases so does speed. As pressure increases so does torque. These values are, however, not limitless. The Hydrotor® loses some energy to heat, but is 92% efficient thus translating a large amount of energy into dependable engine starting.

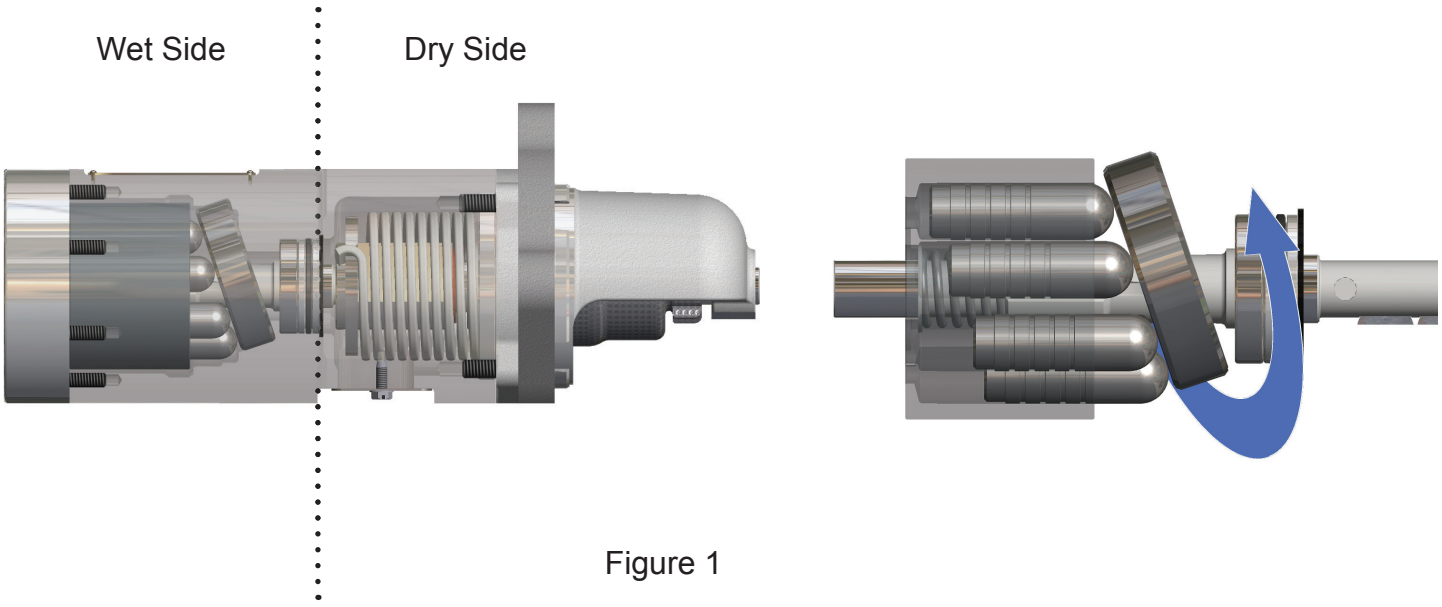


Figure 1

Through the center of the hydraulic starter is a shaft. This shaft is supported on both ends with needle bearings. Mounted on the drive shaft is a drive mechanism. The drive mechanism as highlighted below in Figure 2, is designed to engage with the engine during the actuation of the hydraulic system and disengage after the engine starts. In general terms, when the hydraulic starter speed reaches a threshold, the pinion gear advances forward and engages into the ring gear of the engine flywheel. Note: The pinion gear is machined to have a lead-in chamfer which allows for ease of engagement.

Once the hydraulic starter pinion gear and ring gear are meshed, the starter drives the engine to begin the cranking cycle. When sized properly, the combination of the starters high torque and speed overcome the resting state of the engine (breakaway torque) and the mass of the engine and any parasitic loads (rolling torque). Once the engine starts, the flywheel spins at a rate that overcomes the inertia of the pinion gear. This causes the pinion to disengage and the starter comes to rest.

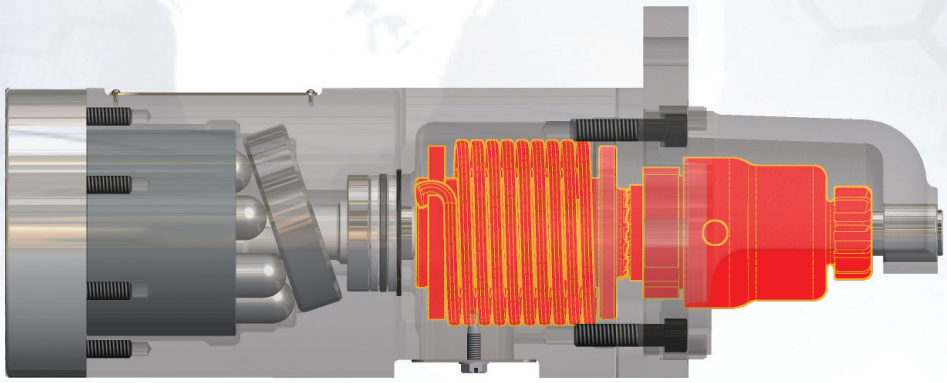
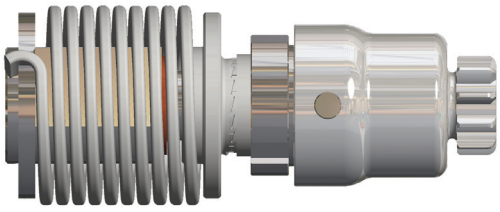
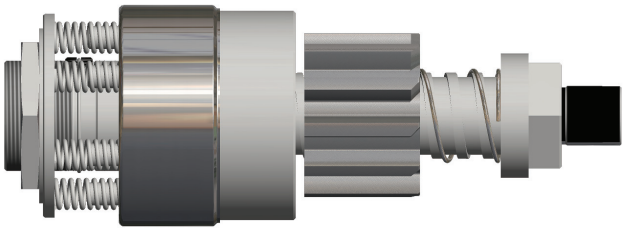


Figure 2

Different drive mechanisms operate in different ways, but the overall principle is the same across all models. Figure 3 below shows the Spring drive which is present on A and B Series starters vs. Heavy Duty Inertia Drive present on C,D, and E Series starters.



Spring Drive



Inertia Drive

Figure 2