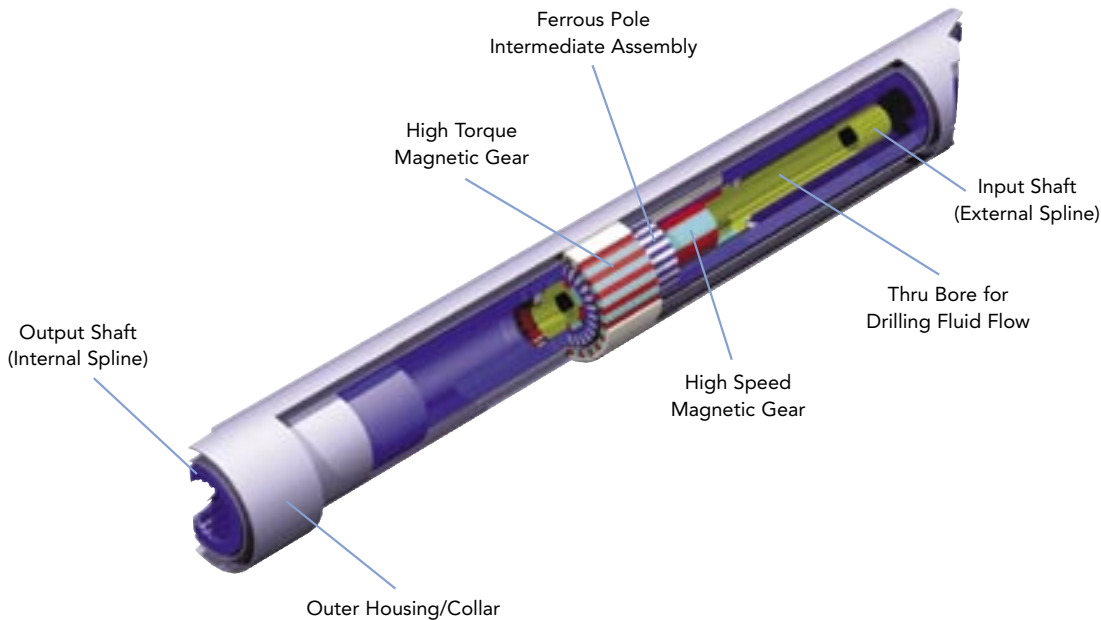


MagneGear™ RMG

Rotary Magnetic Gear for Turbodrill or PDM Application

Patents Pending



- ▶ Totally sealless
- ▶ Totally non-contacting rotating elements
- ▶ Force or speed multiplier / reducer
- ▶ Wide range of ratios
- ▶ Scalable to any size or torque requirement
- ▶ Output shaft rotation can be either the same direction or counter rotating to input shaft

MagneGear™ RMG configured for use with a drilling motor such as a turbodrill, positive displacement motor (PDM) or air motor.

The input shaft shown in yellow is the high speed shaft. You will notice a thru bore in the input shaft to allow drilling fluid flow. The output shaft to the bit is shown on the left side of the diagram.

An important attribute of a RMG device is the isolation of axial force. Axial forces, or thrust, exerted on one member are not directly transmitted to the other members of the RMG. For example, a high axial load from the bit end of a RMG used in a mud motor application would not transfer to the PDM or turbodrill used as the prime mover.

In large diameter applications, high torque densities are achievable through a single stage magnetic gear device. Torque density of greater than 500 lb/ft per linear foot of gear device is achievable in a 9-5/8" diameter, with a through bore of 2-3/4" for flow. For smaller diameters, or for higher gear reduction ratios, multiple

stages can be utilized. For example, it is possible to achieve a 1200:1 reduction ratio through four stages in a 6-1/2" or smaller diameter and still be able to accommodate drilling fluid or production flow. This makes the MagneGear rotary magnetic gear and MagneGear linear magnetic gear systems the only reduction gear devices that we are aware of that allow access or intervention to devices below the gear system through an open central bore in the reduction gear device.

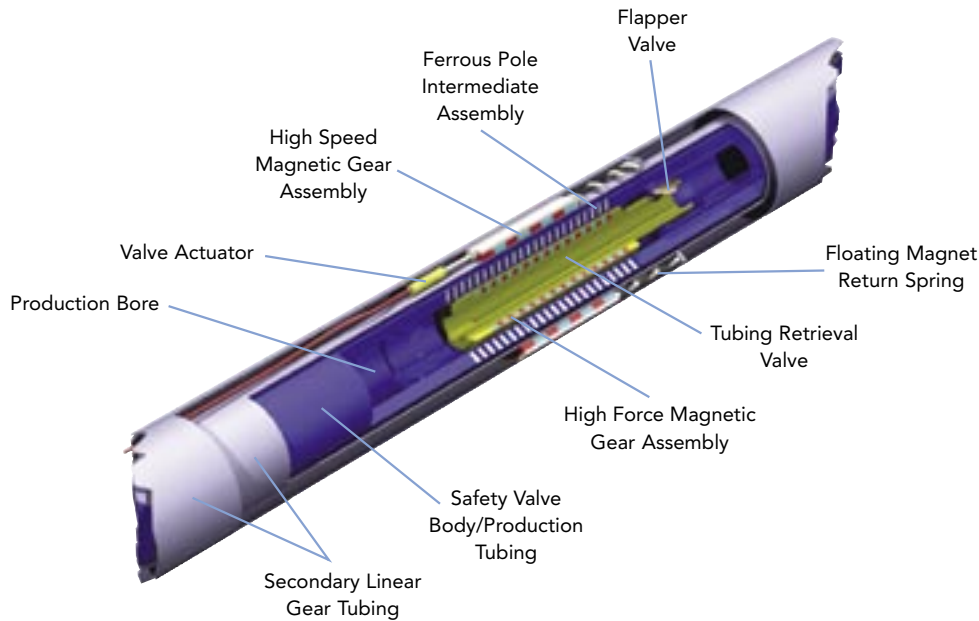
The smallest practical diameter for downhole application requiring moderate-to-high torque output appears to be 3-1/2" unless no mud flow is required through the ID of the RMG. With no flow required through the inside of the RMG device, for example if the RMG is needed to run inside a pressure housing on a tool, it can be practically applied in diameters of 2" or less.

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MagneGear™ LMG

Magnetically Geared and Sprung Safety Valve

Patents Pending



- ▶ Totally sealless
- ▶ Totally non-contacting rotating elements
- ▶ Force or speed multiplier / reducer
- ▶ Wide range of ratios
- ▶ Scalable to any size or torque requirement

MagneGear™ shows a LMG applied to a tubing retrievable surface controlled subsurface safety valve (SCSSV).

Such a design gives the advantage of force multiplication on the tubing retrievable valve. For example, with a 6:1 ratio, which would be appropriate and smoothly operating in the diameters required for a safety valve as described, a 500 pound linear force applied to the input member by the surface controlled actuator would yield 3,000 pounds of linear force on the tubular valve actuator.

Linear magnetic valve operators are currently used in the downhole drilling and completions industries, but they operate on a synchronous 1:1 ratio. Replacing those 1:1 actuators with Dexter's MagneGear linear magnetic gear actuators provides the benefit of force multiplication. If the output force of an existing device is sufficient for application, force multiplication then allows a lighter and thus smaller prime mover. The force of the prime

actuator, be it hydraulic or electric, can be reduced by 80% or more. There are a multitude of similar applications in the area of smart completions, such as sliding sleeves that can benefit from the force multiplying phenomenon of this device.

An alternative embodiment for either the RMG or LMG is to use the gear system to increase speed. For example, it is feasible that a high speed, low torque drill motor could be advantageous particularly in microhole drilling. In this instance an inverted RMG appears to have application.

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