



Western Instruments

Established 1965

WD-Series Coils

October, 2007

This write-up hopes to aid the reader to understand the rationale behind *Multi-Turn, Low Amperage* Coils. WD-Series Coils have become an Industry Standard for the inspection of Threaded Connections used on Drill Pipe, and other Oil Well Drilling Tools.

The science of Drilling Oil and Gas Wells has advanced tremendously over the last 30 years, to where the Drill Stem does not rotate, but the Drill Bit is driven by a 'Mud Motor' fashioned after a Progressive Cavity Pump. This technology has allowed Drillers to Steer the Drill Stem, to where a well might only have a vertical drop of 200 meters, but continues horizontally for over 1000 meters. When this type of Horizontal Well is being drilled, the crew is given accurate telemetry by Monitoring While Drilling (MWD) Instrumentation. This Instrumentation requires the area around the Drill Bit to be free of Magnetism, as the MWD Instrumentation uses the Earth's Magnetic Field as a reference. WD-Series Coils are renowned for their portability and effectiveness in the Demagnetization of Bottom Hole Assemblies (BHA's).

Magnetic Particle Inspection Coils are available in two forms;

1. Traditional High Amperage *Mobile Power Packs* (3-6000 Amps), with a few (3 to 5) wraps of heavy 4/0 cable.
2. *Multi-Turn, Low Amperage Coils* with between 1000 and 2000 Turns of small gauge wire, supplied from a Low Amperage Power Supply.

The accepted *Rule of Thumb* for coils to inspect these BHA's is 1,200 Ampere Turns for every inch of Diameter, thus for an average 6 5/8" OD Threaded Connection, the operator requires almost 8000 Ampere Turns of a DC Field. This DC field permits both the Male Threads (Pin End) and Female Threads (Box End) to be full inspected. AC Fields, induced by a Coil, will not provide enough field to inspect Box Ends.

If a High Amperage Mobile Power Pack is used, it would have to be very close to the Workpiece, with perhaps 40 feet of 4-0 Cable (to achieve a 5 Turn Coil). The Amperage, with average losses, would be in the order of 3000 Amps. These Mobile Power Packs, have a high capital cost, and very high Switch Gear installation costs. For economical use, the Power Pack (not looking very mobile at this point) should be run from a 3 Phase supply of at least 440-480 Volts.

Most high performance testing is done with a DC field, but Power Packs become more expensive if they are Full Wave. *Multi-Turn, Low Amperage Coils* produce virtual DC (from full wave rectified voltage), as the Inductance of the 1000+ turn Coil results in a virtual *Full Wave* DC output.

It is recognized, in all industries where Demagnetization (Demag) is performed, that a Reversing and Decaying DC Field provides the best demagnetization. High Intensity AC will provide Demag on smaller parts, however on Heavy Workpieces, with a very strong residual field, an Alternating Current just simply doesn't work.

WD-Series Coils have quickly gained their popularity in the market, because they excel at *Demaging*, not to mention the relatively light weight and the convenience of the Integral Power Supply. With most specialized MPI testing, virtually all parts require a Controlled Field, and that normally means +/-3 Gauss after testing. This demagnetization is achieved manually, with the standard controls, by Reversing and Reducing the DC field between shots. In some cases WDV-Coils are used to introduce a specialized Magnetic Field, where both ends of a 11.3m (37') length of Casing have the same polarity, which produces a very heavy node, of the opposite polarity, in the middle.

Multi-Turn, Low Amperage Coils can have the field Reversed with the use of a Toggle Switch, and Reducing the Field is simply done by turning a knob. With new Coil Controls, the Output Amperage is constantly displayed, and is an unusual feature on a Mobile Power Pack. To reverse the Field on a Mobile Power Pack, both *Eitherend* Connectors on the 4/0 cable must be removed from their receptacles, and their positions reversed when they are plugged back in. Like a *Multi-Turn, Low Amperage Coil*, reversing the Amperage is done by turning a knob. In the end, a *Multi-Turn, Low Amperage Coil*, can perform a Demag Operation in approximately one-fifth the time of a Power Pack with a 5 Turn Coil.

Multi-Turn, Low Amperage Coils, developed by Walter Gunkle in the mid 1950's, are typically supplied from a Separate Power Supply that has an output of about 12 Amperes at 115Volts DC. These early Coils, which are still being manufactured in the same way, use an Aluminum Bobbin for the Coil form with a Separate Power Supply and remain virtually unchanged after more than 50 years. Unfortunately, little development work was done with this type of Coil until Western Instruments introduced its first WDV-10 in early 2000.

MPI Equipment is not certified by Specification Issuing Organizations (ASTM, ASME, API, etc.), but must comply with the requirements as set out in their documents. The use of a Coil is referred to as *Indirect Magnetization* as the magnetic field is induced into the workpiece. *Multi-Turn, Low Amperage Coils* are also typically employed for *Localized Area* inspection, as described in ASTM E709, and more specifically are defined as *Air Core Coils*. Reference Specifications tend to use complex (and confusing) formulas for the calculation of the *Ampere Turns* required to magnetize a workpiece.

These formula are typically negated in favor of using the faster, more direct method of *Artificial Discontinuities* contained in devices such as a Pie Gauge or Slotted Shims (Castrol Strips or QQL's), which are also approved for *Verifying Systems Performance*.

Western's latest Development in this area is a Coil with the added feature of performing Automatic Reversing DC Demagnetization or *Automatic Ring-Down*®. With the simple press of a button, the Coil starts a series of Shots, with a reverse polarity and reduced amperage. The shots are repeated until the magnetic field is removed from even the heaviest workpiece.

Western currently produces 8, 10, 14, 16, 18, and 25" ID Coils. The jump from 18 to 25" ID, is extensive, where the two larger sizes are primarily designed to Demagnetize Pipeline Pipe prior to Welding. We regularly entertain the production of different ID sizes where the customer requires two units. This is why we produce 16, 18, and 25" Models, that were initially delivered within 8 weeks.