***Willrich Precision Ph 866-945-5742 email: sales@willrich.com***

***THREAD INSPECTION OF PITCH DIAMETER***

**MTG, Inc.** decided to look for answers by studying one of the most successful methods of gaging external threads, the 3-wire system. No one had ever seriously considered this system for internal threads before , it was obvious  the physical characteristics of wires made it impossible to deploy and  seat them in the tight convolutions of a female thread. But the principle was sound, so we overcame the physical problems by substituting " floating balls" of Best Wire sizes for the actual wires. Held captive in caliper fingers and mounted on an indicating gage frame, the balls could be made to simulate three-wire inspection in internal threads, Figure 1.

**LESS GAGING PRESSURE**
     The use of balls, incidentally, eliminates perhaps the only significant shortcoming of wires. The problem is spelled out in Screw Thread Standards for Federal Services, under the heading Limitations of Three-Wire Measurement of External Threads: "When the lead angle and diameter of a thread are such that double contact of the measuring wires occurs, it will be necessary to check the pitch diameter by means of balls rather than wires. For accurate measurement with wires, single contact on each flank must occur. Measuring wires can be used if the following formula is satisfied for a specific thread." Then follows a lengthy compensation formula developed by Werner F Vogel of The Van Keuren Co.

    Because of the possibility that wires may make double contact in threads of certain lead and diameter combinations, Vogel's equation calls for increased gaging pressure to seat the wires--as much as 2 1/2 Ib. in a 1/2-20 thread. This may result in deformation of the wire , the thread or both  ! ! ! !

    Replacing the wires with balls as we have done eliminates seating problems by making spheres rather than cylinders the method of contact. Gaging pressure need be only about 1 oz., or enough to satisfy the inspector that contact pressure is sufficient to register the size.

**HOW ERROR IS ISOLATED**
     To understand how the ball principle isolates thread aspects for errorless measurement, let us first consider the key dimension in any thread; the pitch diameter. By definition, the pitch diameter is an imaginary cylinder along which each cut thread and each web of intervening metal have the same width: one-half the pitch, or P/2.

     Traditionally, the pitch diameter has been checked with thread plug gages. If an inspector could enter the "Go" plug but not the "No Go," the pitch diameter was considered to be within tolerance. Should the "Go" fail to enter, general practice was to deepen the cut until it did. Conversely, should the "No Go'' enter, the cut would be made shallower to prevent its entry.

    The blind spot in this procedure was that it assumed perfection in all other aspects of the internal thread. It ignored the fact that a thread cut to perfect depth will gage undersize if there is lead error, because the mis-matched leads of the thread and the plug gage will have interference. By the same token, a thread cut oversize and having lead error can pass thread plug inspection if the interference is not enough to block the "Go" but does prevent the "No Go" from entering.

  The floating ball system cannot be deceived by errors in lead or helix, no matter how severe or erratic (as in drunken threads), because the balls float laterally to find a perfect seat in the cuts regardless of the width of the metal between cuts, Figure 2. The balls are solid carbide, finished to Best Wire sizes, and will positively establish whether the tool is cutting to PD tolerance, since they measure diametrically across the threaded hole from cut to cut, not from cut to metal.

**What is the importance of gaging from cut to cut? Simply stated, all diameters of a thread are functions of depth of cut. The cut is the constant, an exact matrix of the cutter at every point along the thread. The metal between cuts, however, is an unknown remainder whose P/2 width is a linear function dependent on the accuracy of the lead. A lead with a plus error will widen the metal between cuts; a minus error will narrow it; an erratic lead will result in inconstant widths. *Unless the lead has been proved perfect in advance,  checking the pitch diameter by using the metal as a gaging point is futile.***

**ISOLATING SUBSEQUENT ASPECTS**
    With the ability to isolate and accurately check the pitch diameter, it becomes a simple matter to inspect the remaining thread factors one at a time, isolating extraneous errors at each step. In our system, the same gage frame is provided with additional pairs of fingers, each with a separate function.



**HOW ACCURATE?**
    In this system, much thought has been given to the elimination of normally inherited errors. For example, the gage does not measure. It compares the work piece against an accepted reference such as a plain ring gage or gage blocks, and shows any variation on a dial indicator or electronic comparator. Fingers move on one plane only, along the axis of the indicator, so no radial or angular "scissors effect" errors can be introduced.

    Problems of taper and out-of-round will not fool the system because its point-contact fingers reveal such conditions by displaying various readings when they are moved from one location to another around or along the thread. Repeatability of the MTG gage is excellent, since there is nothing to change successive readings except surface contaminants, and careful cleaning of critical parts can overcome this. The system is so accurate it can be used to certify thread ring gages on the job. In actual tests, it has detected and confirmed errors even in brand new adjustable thread ring gages

