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GAGING MINIATURE SCREW THREADS

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At the time UNM standards were being developed there was no manufacturing equipment or tooling as well as a measuring instrument with sufficient accuracy to reliably produce the very small diameters and pitches to needed tolerances and measure the results. Therefore, it was decided not to gage tapped holes (relying on the tap to be made with sufficient allowance) and use a 100X optical comparator chart for each size, inscribed with multiple pitches of the thread profile and limit lines, for measuring external threads. The charts were not satisfactory as drawing capability limited accuracy even at 100X and the expense and handling of many charts and cumbersome staging and alignment made this impractical. Using measuring wires for checking external threads was rejected as the pressure to seat the wires properly could cause distortion, while a lesser pressure would not produce accurate and repeatable results.

MORRIS realized that no gaging was not practical due to the multitude of applications and requirements which would be encountered far beyond the limited parameters of the watch industry, from where most of the experience derived. Also, close fits were needed to be sure the parts stayed assembled with sufficient engagement to assure maximum torque value. MORRIS set about developing a thread grinding system and measuring method which would meet these exacting requirements.

The end result was a computercontrolled automatic thread grinder which also produced flutes and chamfers for the taps in one chucking. This meant an absolute geometric relationship of all elements as well as very close concentricity and dimensional control. The machine components were massive for stability and positioning systems very accurate to assure repeat performance. A controlled coolant system and closely monitored room temperature maintained stability.

Next, it was necessary to be able to accurately measure the results with consistency. Mechanical means were discarded due to the problems described above and many attempts at optical projection with electronic measuring aids did not produce the repeat accuracies needed. An opto-mechanical-electronic measuring device was the final solution which would consistantly produce reading accurate to .00001" by anyone who was properly trained for this work.
Temperature and humidity control were critical to success and the final solution was a simultaneous heating/cooling system in an isolated room.

This led to the production of GO and NO GO thread plug gages of sufficient accuracy to leave enough tolerance for practical production and be easy to use. External threads presented more of a problem and solid ring gages (split rings could easily go out of round) used at first are being replaced by segment gages set by very accurate plugs for close control.

When gaging is used it is important that the product being checked is produced with precision ground tooling (taps, chasers and thread rolls) or single point external threading. These tools can be checked on an optical comparator at 200X to be sure they are positioned to allow maximum production as well as being within limits after allowing for gage tolerances. The thread form produced with ground tooling will also provide maximum thread tooth volume and full engagement of mating flanks which, with close tolerances, also produces the assembly stability and the maximum

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torque noted above. All MORRIS threaded parts must pass GO/NO GO gaging and all other elements are checked to approved quality assurance procedures. Our screw machine cams are computer generated to very close tolerances to be sure that each tool performs exactly as needed to produce precise (CNC type) results.

Due to the critical limits of miniature screws threads it is best to procure taps, gages and other products from the same manufacturer. Lead and angle error as well as drunkeness (deviation from the true helical path of the lead) are the primary reasons for sole source purchase. Lead causes a pitch diameter adjustment of 1.732x the error and angle a lesser amount by a more complicated calculation. Drunkeness is a harder element to measure, but at MORRIS the production equipment described above negates this problem. Thus, products could be within allowable limits but when used with one from another source could still cause problems, especially in the smaller sizes. Producers tend to limit their production of miniature tooling to one machine so that the output will carry the same errors consistently and cancel any adverse effect in the end use.

When checking UNM screw threads it is important to realize that this standard was developed using meteric parameters. Although these were translated to english units for convenience, they are produced and measured to the metric system for worldwide consistency.

In using gages a light touch is mandatory. Care should be taken in mating the part's thread with the gage to be sure they follow the same helical path. If any resistance is encountered, stop immediately and reverse direction. GO gages should accept the thread freely and NO GO gages should produce resistance within three turns. Remember, this is an inspection and not a manufacturing tool. Any wrenching pressure applied to try to make a thread pass will quickly wear out this expensive, high precision instrument.