FASTENER INNOVATION

CONIC THREAD GEOMETRY 3.5

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INTRODUCTION

A screw thread and a new thread, a conic thread, will be shown on a right circular cylinder. The conic thread will also be shown on a right circular cone. Although the screw thread and the conic thread appear similar, even having some defining things in common, the conic thread is different and has different properties.

THE CYLINDER

Both the screw thread and the conic thread are defined with respect to the same helix, H, on a right circular cylinder. Figures 1 and 2 illustrate H with a helical angle, α, and circumference, C. In screw thread technology, the pitch line is λ_1. λ_1 is on the same plane as the axis of the cylinder and is the unit of measure for a thread. λ_2, the length used in the conic thread, is the line perpendicular to the tangent at any point on H. λ_1 and λ_2 have the same starting point but different ending. The helical angle, α is the arc tangent of the pitch divided by the circumference and is geometrically identical at both locations.

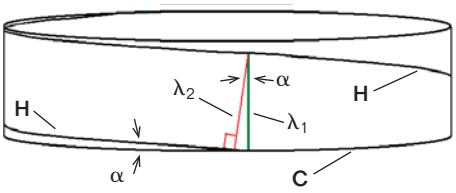

Figure 1. Cylinder with a helix

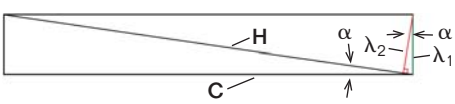

Figure 2. Rolled-out strip of the cylinder and the helix

Figure 2 is the cylinder in Figure 1 rolled out flat. λ_1 is the pitch width of the screw thread. λ_2 is the perpendicular width of the conic thread. H is the helix, and C is the circumference of the cylinder. The angle, α, is the same at both locations. λ_1 and C are at right angles; λ_2 and H are at right angles to each other.

Figures 3 and 4 are for proving that the screw thread and the conic threads are different. In Figure 3, the λ_1 line is shown with a v-shaped thread. The v-shape has 60 degrees per side and is an equilateral triangle. The proof is a proof by contradiction. Assume both the screw thread and the conic thread define the same bottom track. This implies that the altitude in both isosceles triangles is identical. This can't be possible unless α is zero, which means we don't have a helix on the cylinder!

THE CONE

The helix angle α in Figure 2 is a constant for a cylinder derived from the arc tangent of the pitch λ_1 divided by the circumference, C. On the surface of a cone, there is a similar angle, β that is the pitch, λ_1, divided by a circumference, C, at a given diameter. The β angle is different for every diameter on the cone.

The cone shape with a spiral wrapped around it will have a constantly changing β angle at any point on the helix that is at a

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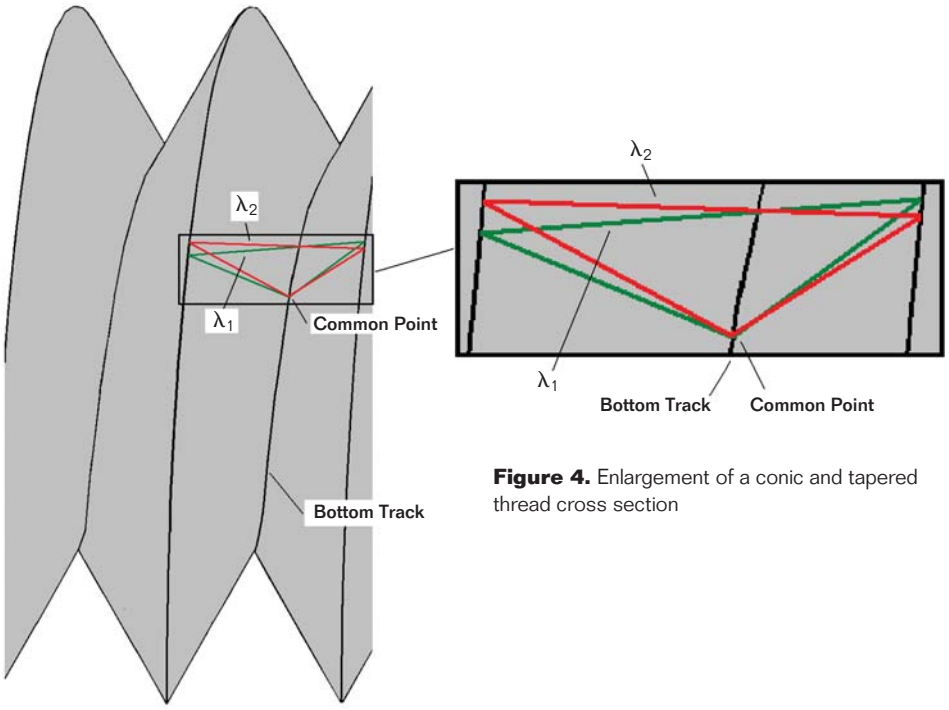

Figure 4. Enlargement of a conic and tapered thread cross section

Figure 3. Larger cylinder used to demonstrate the conic and tapered thread differences

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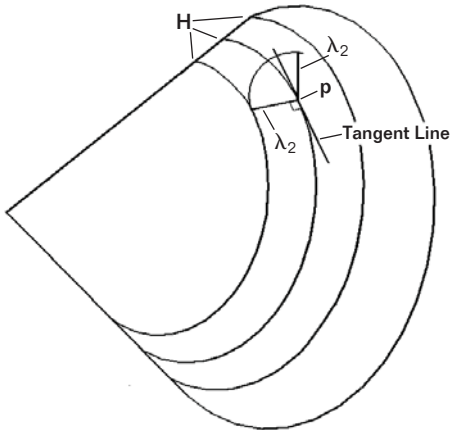

Figure 5. Perpendicular line, λ_2, to the tangent at p, rotated into position

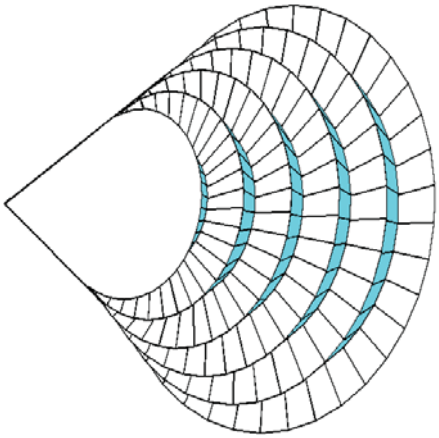

Figure 7. Conic thread perpendicular lines, λ_2, replaced with v-shaped thread profiles

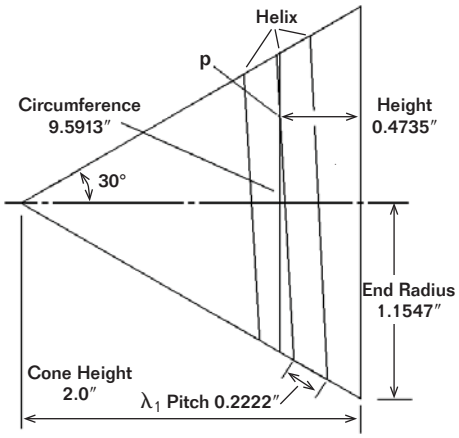

Figure 9. Cone with measurements and a point, p, used in the examples

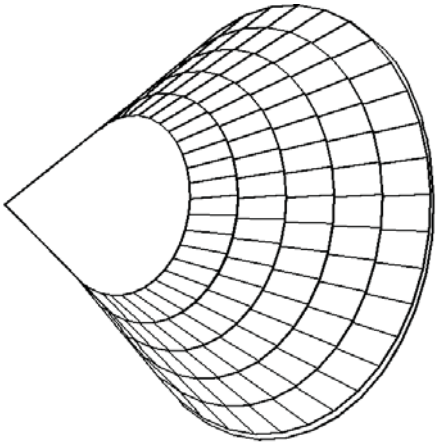

Figure 6. Multiple perpendicular lines, λ_2, forming the outline of the conic thread

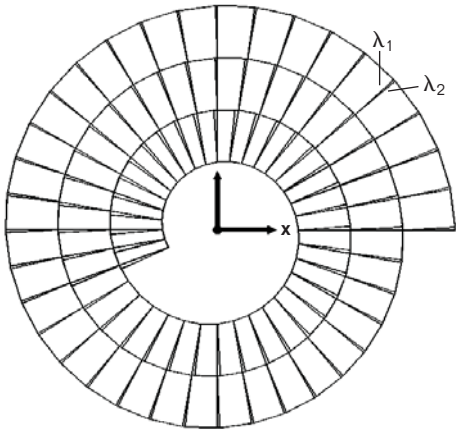

Figure 8. Multiple perpendicular lines, λ_2, and tapered pitch lines, λ_1, on a disk

different diameter. At any point, p on the helix, a tangent line is used to describe the perpendicular orientation of the conic thread.

The construction of the conic thread on a cone is similar to its construction on a cylinder. Referring to Figure 5, a point, p, is chosen on the helix, H. A tangent line is constructed at the point, p, and a perpendicular distance, λ_2, is rotated until it intercepts the next helix as shown. Figure 6 is a collection of λ_2 perpendicular lines calculated from their respective points, p, on the helix. Figure 7 has the λ_2 lines replaced with the profile of a v-shaped thread. That shape forms an equilateral triangle. It could be any shape, as in square, acme, knuckle or buttress thread.

The range of the conic thread is from cone angle 0 to 90 degrees, with 0 degrees being a cylinder in Figure 1 and 90 degrees being a disk. Figure 8 is such a disk with multiple tapered λ_1 and conic λ_2 lines.

Figure 9 shows a specific cone to illustrate the above processes. The cone has a 30-degree angle, height of 2.0″, and an ending radius of 1.1547″. That cone is given a helix with 0.2222″ pitch. Reference point p1 is at height of 1.5265″, and the circumference circle is 9.5913″. Its β angle at point, p, is the arc tangent of the pitch divided by the circumference, equaling 1.33 degrees. This is a tangent to the curve, not to the surface.

CONCLUSION

The screw thread and conic thread are different, and the conic thread has different properties. These properties were not explained here, but the purpose of this geometry is to achieve total surface contact.

Total surface contact will provide the conic thread with several inherent abilities. It will create a seal, conduct heat more efficiently, transmit vibration instead of absorbing it because there is no clearance space to move in, allow repeated precision positioning, and it cannot be over-tightened.

Each of these inherent properties has to be confirmed through testing. Screw threads have 30 to 35 percent surface contact, and tapered threads can be close to 50 percent. They have been thoroughly tested and lack the inherent qualities claimed in the conic thread. ■

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Dale E. Van Cor invented three fasteners and new gears in two transmission systems. This includes developing the software to engineer and generate the Gcode for 5-axis machining. He owned a software development company for 15 years and created 57 turn key systems. To reach Dale, email him at dale@wavethread.com or call 603.239.4433.

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