Chapter 6

Improved Bit Geometry Proposal

6.1 How to Fundamentally Improve Bit Design

A sectional view of the screw and bit, Fig. 6.1 shows the common normal along which the force ***F*** acts as a standard Phillips bit mates with a screw. Contact occurs at the corner between the screw top and the wall of the recess. This results in the normal shown. The normal intersects the horizontal at an angle θ, defined in Fig. 5.10. The vertical component of the force vector ***F***, defined in equation (2) as $\boldsymbol{F}_{cam\text{-}out}$, will increase as θ increases.

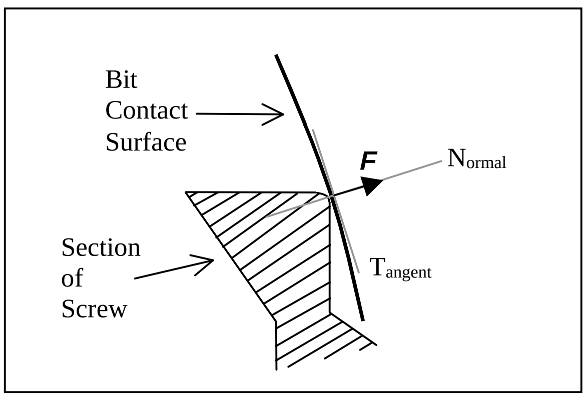

Figure 6.1 Bit/Screw Interaction for Current Bit

When designing new bit geometries, It is clear that one design goal should be to decrease the angle θ as much as possible. The optimum design would result in a mating geometry with the common normal parallel to horizontal.

Phillips's patent application specifies that the bit was designed to cause a firm wedging engagement between the bit and the screw [Phillips]. This wedging engagement was intended to hold the screw onto the bit so that it could be driven in hard-to-reach places without the guidance of a hand on the screw. The bit contact on the corner of the screw is a result of the bit being designed for this wedging. Today magnetic bits are used to help keep the screw on the bit prior to driving.

Designing the contact point of the bit and screw to be on a sharp corner is not ideal for two reasons. First it results in large Hertzian contact stresses at the most critical geometric location, which accelerates wear [Archard]. Second, it allows wear to rapidly degrade the bit and increase the cam-out force in an ever-increasing cycle. One way to minimize the angle of the normal with horizontal is to move the contact of the bit off of the corner of the screw and down to the internal walls of the screw. The screw walls are nearly parallel with the axis of the screw making the normal between the bit and screw contact ideal.

Figure 6.2 illustrates how contact on the screw-slot face will dictate the direction of the normal independently of the bit's geometry.

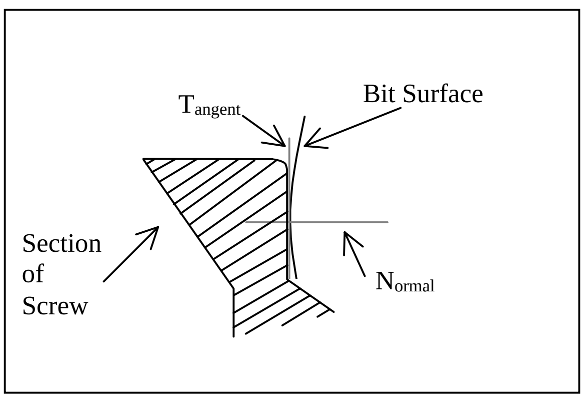

Figure 6.2 Ideal Bit Screw Interaction

6.2 Proposed Bit Geometry

The contact surface of the Grabber bit in Fig. 5.6, as well as the contact surface of most modern bits used with power drivers, appears to be manufactured with at least a slight taper around the point of contact. This can be clearly seen by looking at the contact surface of the bit from the view marked B in Fig. 5.6. The surface contact laws in chapter 5 imply that wings of an ideal bit would not taper near the point of contact. Additionally as previously discussed the contact of the bit and screw should not occur at the corner of the screw recess. The following proposed geometry rectifies both the problems associated with the taper of the contact surface and the contact occurring at a sharp corner.

Figure 6.3 shows one of Phillips's geometries (2,046,837) as it was patented in 1934.

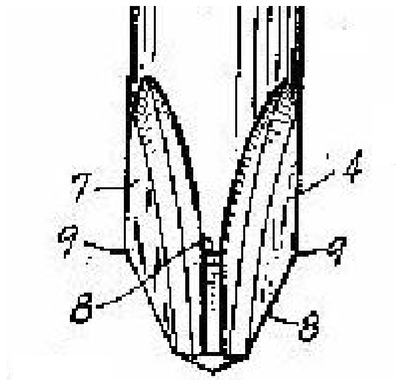

Figure 6.3 Phillips Geometry
(after U.S. Patent # 2,046,837)

This geometry is similar to that of modern bits other than the contact surface (as defined in section 5.3) does not taper. (Please note that in Phillip's patent 2,046,837, he specifies that the contact surfaces, shown as 8 in Fig. 6.3, are to be parallel, i.e. non-tapering. These surfaces were specified to be parallel starting at the point marked 9, continuing down the bit to the terminal end of the driver.)

Although the geometry shown in Fig. 6.3 does not taper, the contact point will occur on the corner of the screw recess if there is angular misalignment between the bit and screw. To eliminate the concerns of tapering and corner contact, It is proposed to take the geometry as shown in Fig. 6.3 and modify it by cutting a relief in contact surface of the bit. This relief is to be located in the area at which the screw corner would contact the bit surface, as shown in Fig. 6.4.

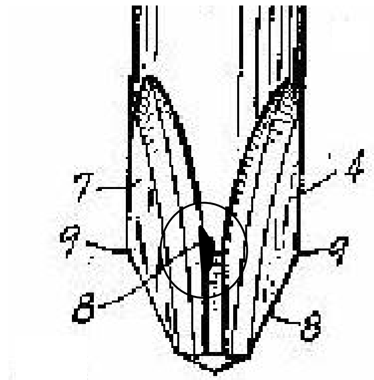

Figure 6.4 Proposed Bit Geometry
(modified from U.S. Patent #2,046,837)

Changing the surface in the described manner eliminates the possibility of the contact point being on the corner of the screw (even with angular misalignment) and forces it to occur on the flat interior surface of the screw slot. It should be noted that cutting the relief into the wings might weaken the bit, but the relief has been radiused to reduce the stress concentration factor.

The contact of the new geometry, shown roughly in Fig. 6.5, will occur along the vertical portion of the bit, not on the corner.

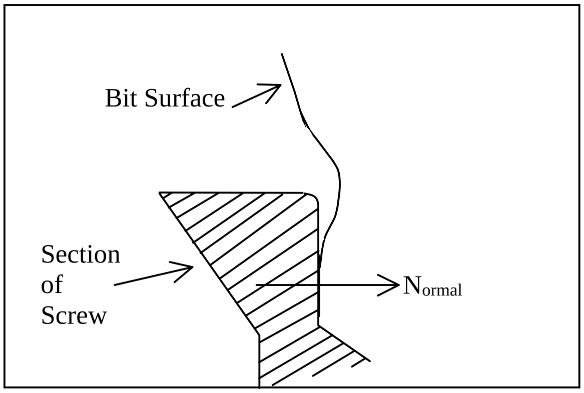

Figure 6.5 Proposed Bit Contact

This contact will result in a common normal perpendicular to the wall of the slot, which will eliminate cam-out force and result in the force vector ***F*** acting solely in the horizontal direction.

The proposed geometry should decrease wear significantly by decreasing Hertzian and Blok normal, sliding and thermal contact stresses. Eliminating contact at the sharp corner will significantly reduce the normal contact stress since the Hertz model is based upon the relative radius of the two surfaces [Archard]. Shaping the contact surface of the bit so that the resulting common normal of the surfaces is perpendicular to the long axis of the bit and screw will eliminate the cam-out force. Without cam-out force, the tendency of bit to leave the recess it significantly reduced, therefore significantly reducing relative motion between the bit and screw. Relative motion between the bit and screw will result in sliding and thermal stresses that can lead to severe local wear [Winer & Cheng]. Eliminating cam-out force, reduces relative motion, and reduces the possibility of wear from thermal stresses.

This new bit concept is being considered for a patent application.