Gear Rolling & Sliding velocity

Gear tooth sliding velocity is defined as a difference between rolling velocities of teeth in mesh. For two involute profile teeth in mesh, at a given point on the line of action, a product of a radius of curvature and a rotational speed, calculated for pinion and gear respectively, are not equal and therefore the resultant rolling velocities are different. Pitch point, a location where the pitch circle intersects the line of action is the only contact point for meshing teeth where there is pure rolling.
At any other location during the interaction of tooth profiles there is relative sliding. The amount of sliding increases as the contact point moves away from the pitch point.

Tangential velocity (tangent to the pitch diameter circle) calculated at a given point on the involute profile.

$$v_{TpA} = \frac{2\pi R_{pA}}{60} * n_P$$

$$v_{TGA} = \frac{2\pi R_{GA}}{60} * n_G$$

Where: $v_{TpA} - \ tangential\ velocity\ at\ point\ \mathrm{A},\ \ pinion\ [in./sec.]$
$n_P - \ RPM, pinion$
$R_{pA} - \ radius\ to\ point\ \mathrm{A}, pinion\ [in.]$
$v_{TGA} - \ tangential\ velocity\ at\ point\ \mathrm{A},\ \ gear\ [in./sec.]$
$n_G - \ RPM, gear$
$R_{GA} - \ radius\ to\ point\ \mathrm{A}, gear\ [in.]$

Rolling & sliding velocity

For conjugate spur gear teeth, at an arbitrary point on the involute curve, sliding velocity is expressed as the difference between rolling velocities of a gear and a pinion) and can be determined using the following equation:

$$v_s = v_{RpA} - v_{RGA}$$

Where: $v_S - \ sliding\ velocity\ [in./sec.]$
$v_{RpA} - \ rolling\ velocity\ at\ point\ A, pinion\ [in./sec.]$
$v_{RGA} - rolling\ velocity\ at\ point\ A, gear\ [in./sec.]$

Rolling velocity equations:

Rolling velocity component v_R of the tangential velocity v_T can be calculated utilizing trigonometric functions. Note: at a given point, the rolling velocity v_R is tangential to the involute curve and perpendicular to the normal component (v_N) of the tangential velocity v_T. It can be seen that the angel between the normal component and the tangential velocity is equal to the pressure angle at that point.

$$v_{RpA} = v_{TpA} * \sin\phi_A$$

$$v_{RGA} = v_{TGA} * \sin\phi_A$$

In terms of the radius of curvature:

$$v_{RpA} = \frac{2\pi\rho_{pA}}{60} * n_P$$

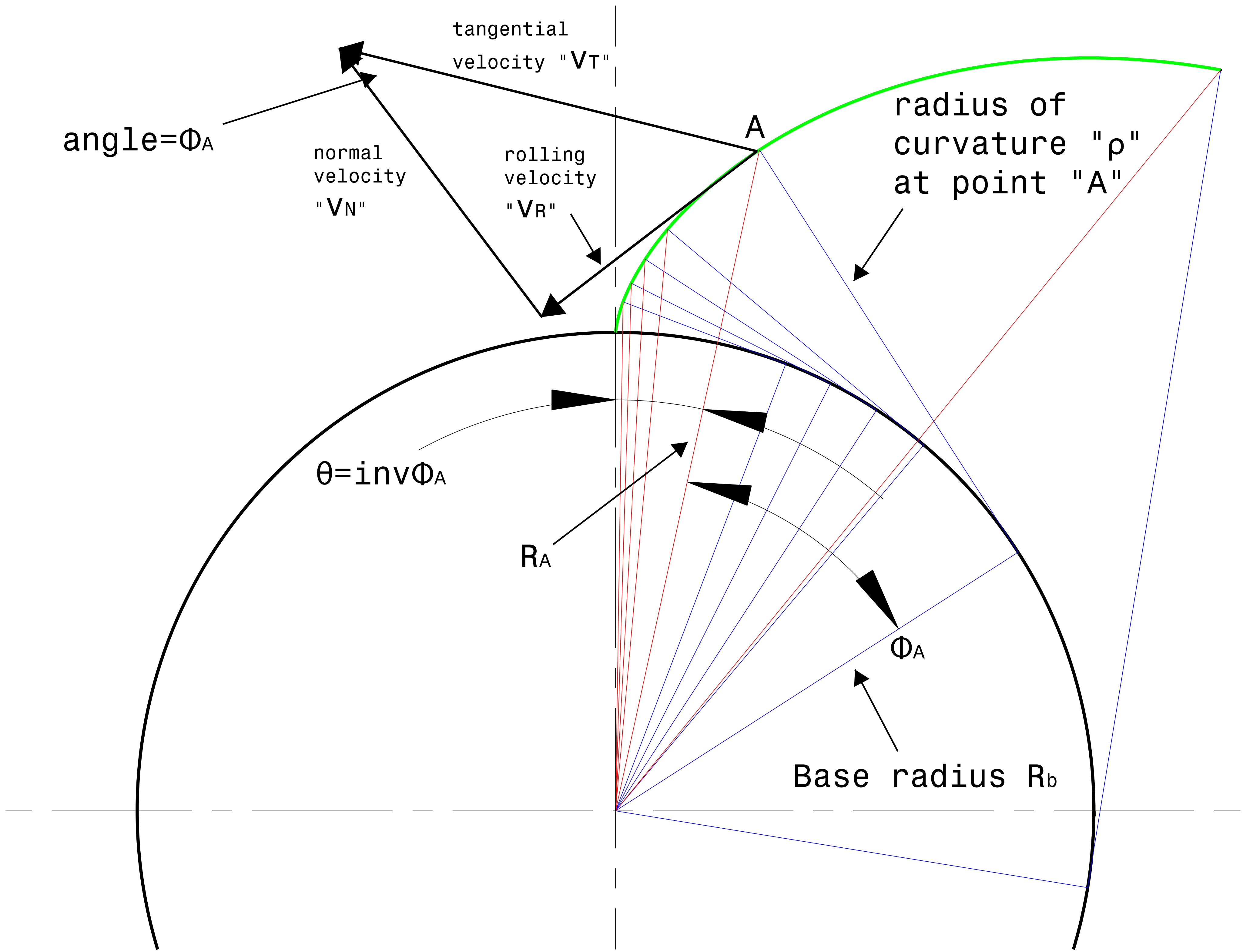
$$v_{RGA} = \frac{2\pi\rho_{GA}}{60} * n_G$$

Where: $v_{RpA} - \ rolling\ velocity\ at\ point$ A, $pinion\ [in./sec.]$
$\rho_{pA} - \ radius\ of\ curvature\ at\ point$ A, $pinion\ [in.]$
$v_{RGA} - \ rolling\ velocity\ at\ point$ A, $gear\ [in./sec.]$
$\rho_{GA} - \ radius\ of\ curvature\ at\ point$ A, $gear\ [in.]$
$\phi_A - \ pressure\ angle\ at\ point\ A\ [deg.]$

It can also be expressed in terms of angular velocities:

$$v_s = s(\omega_P - \omega_G)$$

Where: $\omega_P - \ angular\ velocity, pinion\ [rad./sec.]$
$\omega_G - \ angular\ velocity, gear\ [rad./sec.]$
$s - distnance\ along\ the\ line\ of\ action\ to\ the\ arbitrary\ point\ chosen\ from\ the\ pitch\ point\ [in.]$



tangential
velocity "VT"
angle=ΦA
normal
velocity
"VN"
rolling
velocity
"VR"
A
radius of
curvature "ρ"
at point "A"
θ=invΦA
RA
ΦA
Base radius Rb