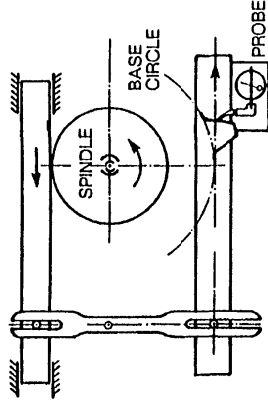


See example in Fig 9-14 which shows total accumulated pitch variation,  $V_{ap3}$ , within a sector of 3 pitches.

**9.4 Profile.** Profile is the shape of the tooth flank from its root to its tip. The functional profile is the operating portion which is in actual contact during tooth mesh, and cannot extend below the base cylinder.

**9.4.1 Profile Inspection Methods.** The normal measurement methods of profile are with generative, coordinate, or portable involute checking instruments.

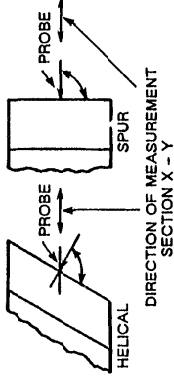
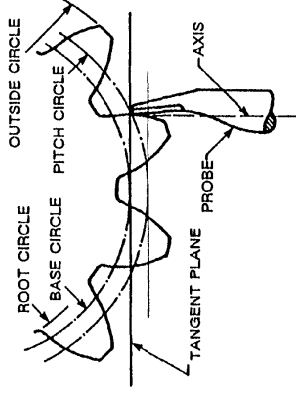
**9.4.1.1 Generative Involute Checking Instruments.** The most common instruments used for inspection of profile are generative involute checking instruments. These instruments measure the variation of the actual profile from a nominal involute profile which is generated by the instrument. Generating the nominal involute requires a tangential movement of a measurement probe on the surface in a synchronized, linear relationship with rotational movement of the gear mounted on the instrument spindle (see Fig 9-15).



**Fig 9-15 Schematic of Involute Inspection Device**

Generative involute checking instruments may employ a master base circle or master involute cam to generate the nominal involute curve. Such instruments may include a ratio mechanism which relates the actual workpiece base circle to the master base circle. Generative involute checking instruments may employ a Computer Numerical Control electronic drive system to generate the nominal involute curve.

The gear must be accurately mounted and held with its datum axis of rotation in coincidence with the instrument spindle axis. Additionally, the probe tip must be accurately positioned within the plane tangent to the base cylinder with its zero roll position precalibrated (see Fig 9-16).



**Fig 9-16 Profile Measuring Method**

Probe tips may be chisel point, disk, or spherical, provided that accurate positioning is maintained. Measurement of extreme profile modification may require correction for shift of probe contact point.

It is often desirable to orient the measurement probe path of motion normal to the tooth surface. It should be noted that this Standard specifies profile tolerances in the transverse plane. If measurements are made in the normal plane, all values must be corrected by dividing by the cosine of the helix angle before comparison against the tolerances.

**9.4.1.2 Coordinate Measurement Inspection Instruments.** Involute profile can be inspected by non-generative, coordinate

measurement instruments. Such instruments indicate the tooth profile by a series of discrete points, storing the coordinates of each point. The variation of the actual profile from the nominal is then determined by comparison of the stored test point coordinates against calculated coordinates of the theoretical nominal profile (see Fig 9-17).

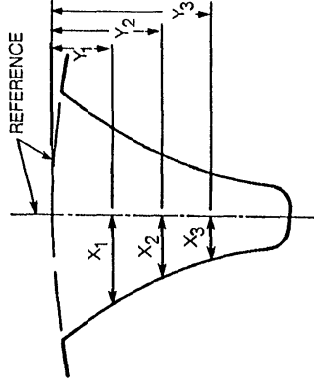


Fig 9-17 Profile Inspection by Coordinates (Tangent to the Base Circle)

Coordinate measurement inspection instruments may operate in two dimensions (X and Y coordinates) or three dimensions (X, Y, and Z coordinates). Measurement of an involute profile with two dimensional systems requires accurate mounting of the gear with its axis perpendicular to the X-Y plane. Three dimensional systems require alignment of the gear axis parallel to one of the three instrument axes. This may be accomplished by accurate mounting of the part, or mathematically adjusting the instrument axis to coincide with the gear axis. Coordinate measurement inspection instruments commonly use spherical measurement probe tips which require correction for shift of the probe contact point.

**9.4.1.3 Portable Involute Checking Instruments.** Profile measuring instruments are generally fixed type machines. Gears to be tested must be brought to the instrument and accurately mounted, typically on axis, between centers or on a face plate. However, for very large gears it may be preferable to employ a portable involute

checking instrument which can be taken to the gear. Such instruments may operate on a variety of generative or non-generative principles. The portable instrument must be accurately mounted at a known distance from, and in alignment with, the gear axis. This often requires extra care in design and manufacture of the gear blank.

**9.4.2 Profile Charts.** Amplified traces of profile inspection test results should be presented on charts which are calibrated for degrees of roll or rolling path length as well as magnification of measured variation (see Fig 9-18).

An unmodified profile with no variations will be charted as a straight line. Excess material on the profile is considered a plus variation while insufficient material is considered a minus variation. In addition to identifying the location and magnitude of the highest point on the profile or the maximum profile variation, these charts are valuable for determining profile characteristics such as tip rounds, undercut, and tip or root relief (see Fig 9-19).

**9.4.2.1 Profile Tolerances.** The profile tolerances listed in this Standard are to be interpreted by a standard "K" chart, as shown in Fig 9-20. The tolerance is the allowable envelope of this standard "K" chart for each portion of the functional profile. Profile traces which fit within the shaded zone are considered acceptable.

Profile tolerances may alternatively be specified by a tabular method. This may be particularly useful with inspection systems capable of handling test data in digital form.

**9.4.3 "K" Chart Tolerance Modification.** It may be desirable to modify the involute profile "K" chart tolerance zone. Such modifications might be in response to specification of special design characteristics such as tip relief. Additionally, profile "K" chart tolerance modifications may be desired to relax or tighten control of certain characteristics of an unmodified involute form. In such cases, specific agreements must be made between manufacturer and purchaser, since modification of the profile "K" chart tolerance is beyond the scope of this Standard. Refer to Appendix C for examples of modified charts.

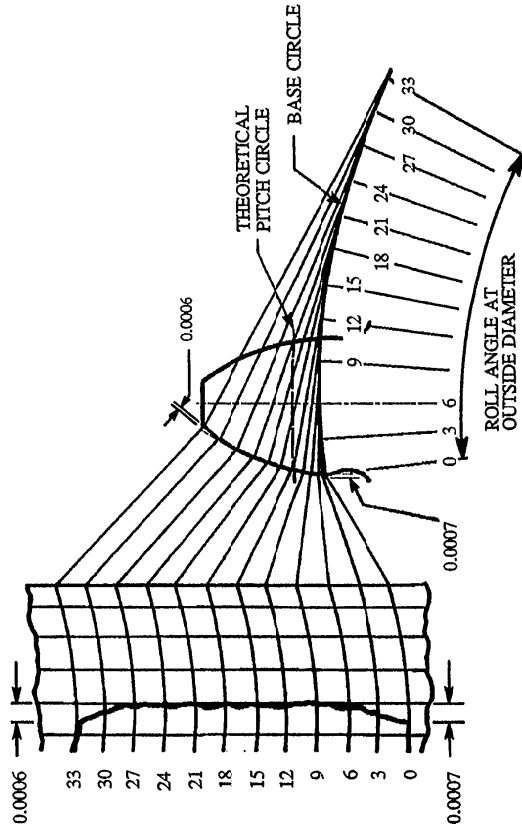


Fig 9-18 Graphic Charting of Points On a Profile

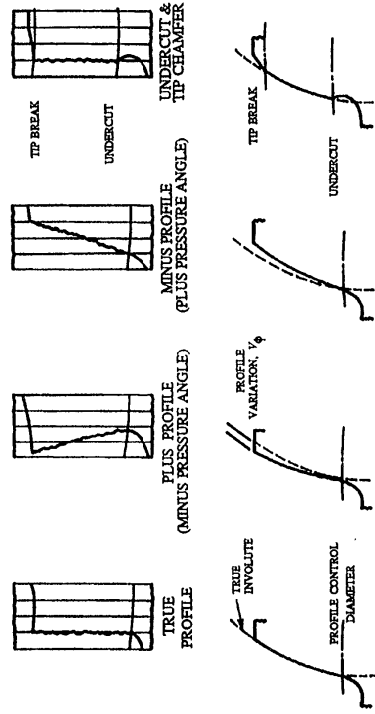


Fig 9-19 Typical Tooth Profile Measurement Charts