PLASTIC DEFORMATION. The type of deformation takes place when the applied stress exceeds the elastic limit of a material is called plastic deformation or plastic strain. It is a result of a permanent displacement of atoms in the material whereas in elastic strain the same neighboring atoms are retained after the force is removed.

Considering again that the mechanically produced surfaces in normal electrical contacts are rough, the pressures in the small asperities become very high, so some plastic deforn1ation is inevitable. Forces well under one gram cause plastic deformation to some degree in almost all cases.

It is quite a convenience that a certain ball indentation hardness, namely Brinell (H_B), is expressed in terms of the area of plastic deformation that is created by the application of a given force, i.e., H_B is expressed in kilograms/millimeter^2. The Brinell hardness also has been shown to have a distinct relationship to the total area of real contact that appears when asperities are brought together and deformed plastically so as to support a given applied load. Expressing this equivalent area in terms of its radius (a), we find that

$$a = 1.78 \times 10^{-2} \sqrt{\frac{P}{H_B}} \qquad \text{Eq. 1.2}$$

where a = radius in millimeters
P = force in grams
H_B = Brinell hardness of the softer member
and in common engineering units the equation becomes

$$a = 7.0 \times 10^{-4} \sqrt{\frac{P}{H_B}} \qquad \text{Eq. 1.2a}$$

where a = radius in inches
P = force in grams
H_B = Brinell hardness of the softer member

Equations 1.2 and 1.2a apply when the deformation is principally plastic in nature and is restricted to bulk geometries that would produce essentially round equivalent load bearing areas. Thi would include spherical members pressed against flat members and crossed wires or rods of about the same diameter. Note that the Brinell hardness used is always the hardness of the softer of two mating materials and this is the member which yields plastically.