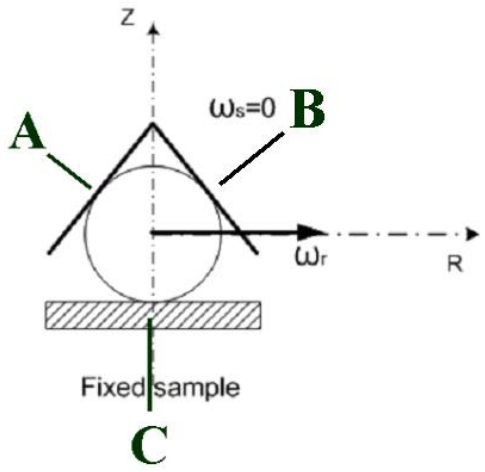
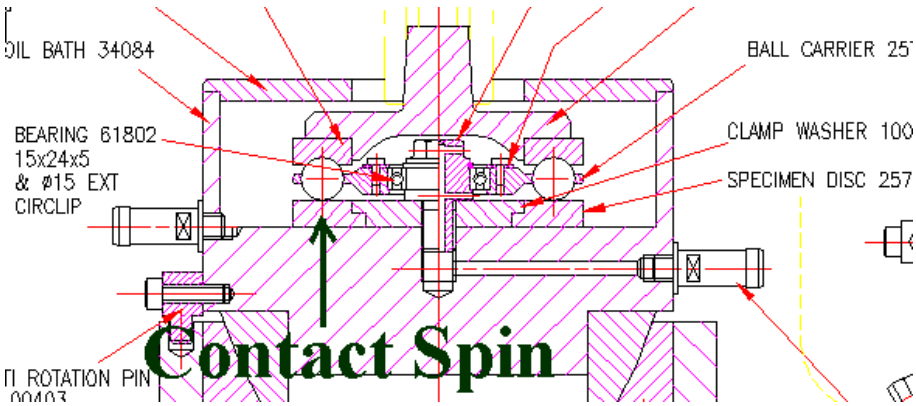
Guidance – Contact Spin & Ball on Disc Geometry

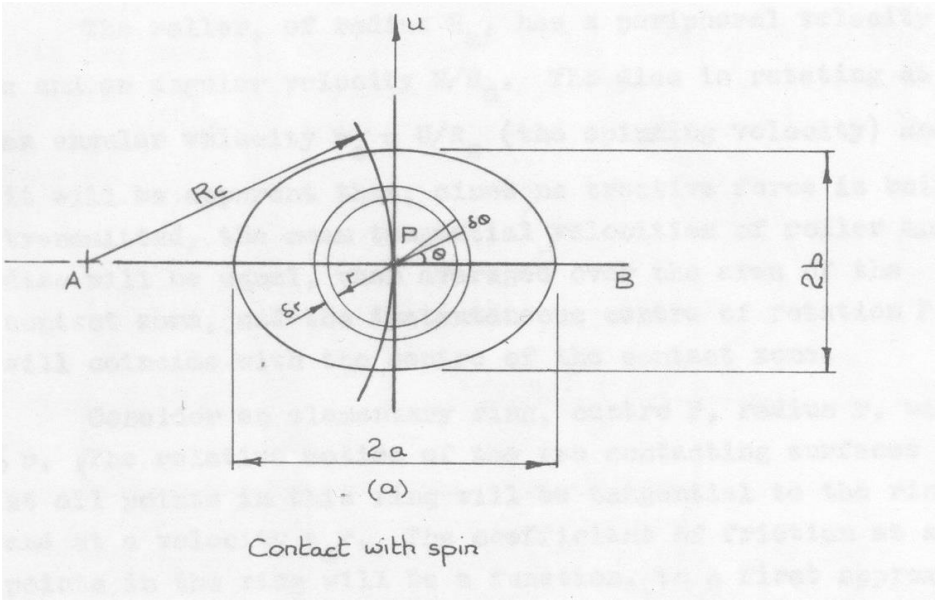
Contact Spin



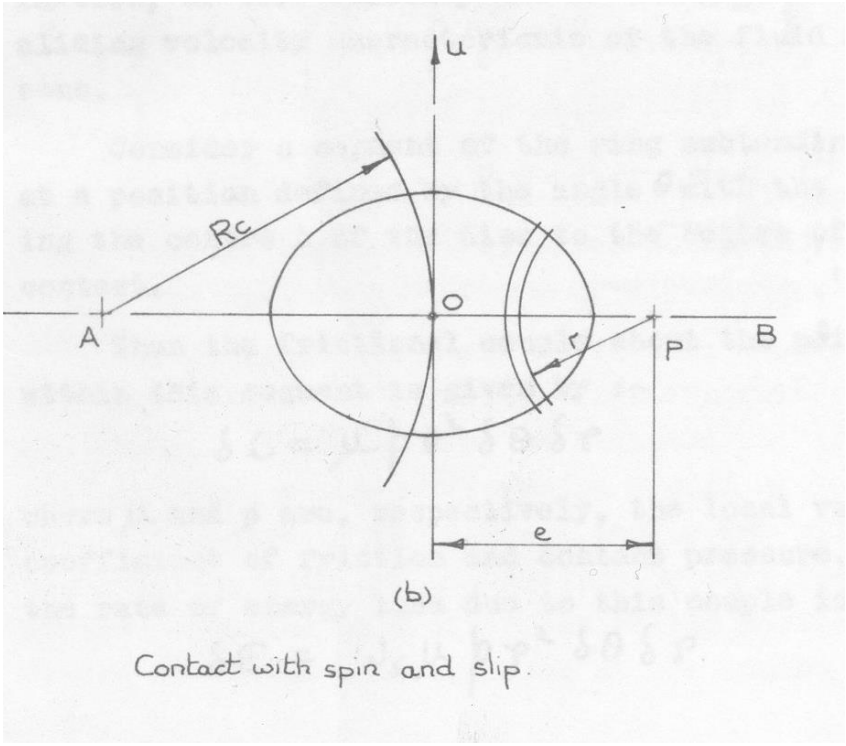
If the ball is running in a straight line on the fixed sample, in other words, rotating about the axis R, then contact C will have pure rolling but contacts A and B will be subjected to "spin" in the contact. In this case, failure will occur at either contact A or B before C, hence as a test assembly, this will only work as a device for testing rolling contact fatigue in a contact with spin, not pure rolling!

If the ball is running around a circular track instead of in a straight line, there will be spin in all three contacts, spin being defined as rotation within the hertzian contact. This is what develops the traction force within a nominally pure rolling contact.



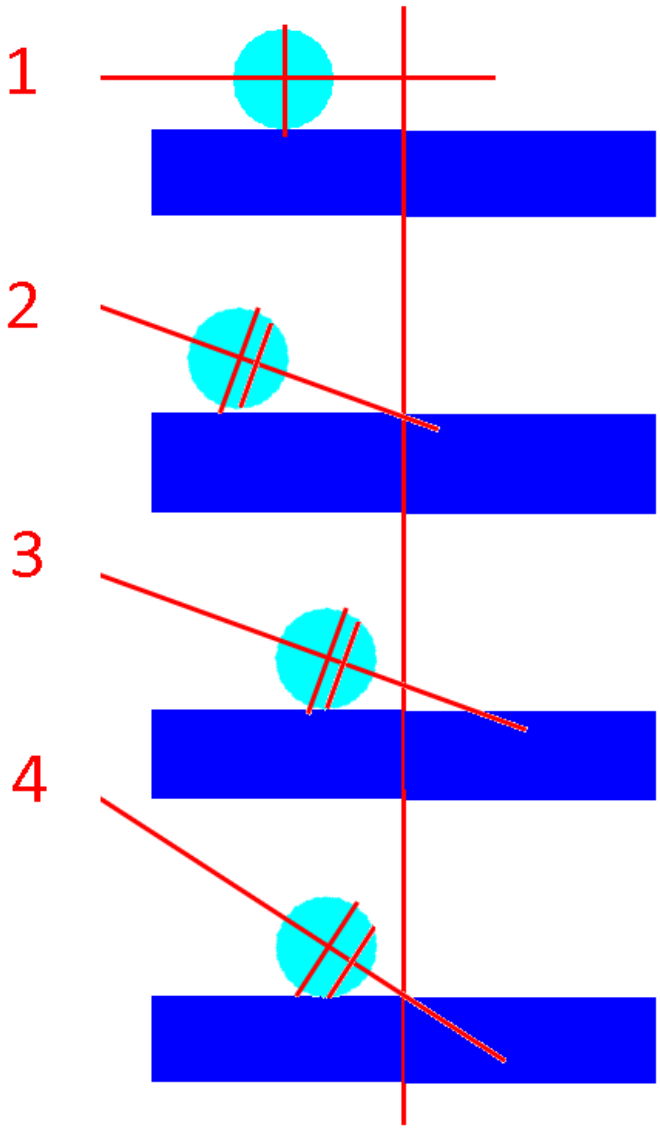


However, because the traction developed by the spin in all three contacts has to be balanced somehow, there is bound also to be slip in each contact, hence:



It is not what the ball is doing, it is what is happening in the hertzian contact that counts and the only way to analyse spin is to look at the velocity vectors within the contact. If they are all straight and parallel, there is no spin. If they are not, then there is either spin or skew, or frequently, both.

Ball on Disc Geometry



It follows that a ball on disc test machine designed with the ball rotational axis horizontal (1) will create a contact that combines both rolling, with or without slip in the rolling plane, and spin. At zero slide-roll ratio, this contact will generate traction, because of the spin component.

To eliminate spin in the contact, the rotational axis must be tilted at an angle, so that the axis aligns with the centre of the disc rotational axis in the plane of the ball-disc contact, in other words, on the surface of the disc (2). This will produce pure rolling between ball and disc, but at a ball rolling diameter that is less than the ball major diameter. Note that if the ball rotational axis does not pass through the centre of the disc rotational axis, in other words, when viewed from above, it is off-set from a disc diameter, then the contact will be subjected to “skew”. This also affects the traction coefficient.

If, having tilted the ball rotational axis by a fixed angle, the disc track radius is reduced (3) such that the axes no longer pass through the same point on the surface of the disc, then the contact once again generates spin.

To avoid this, the angle of the ball rotational axis must be increased still further, to bring the axes back into line (4). This will eliminate the spin, but reduce the rolling diameter on the ball still further.