Anti-skating force analysis

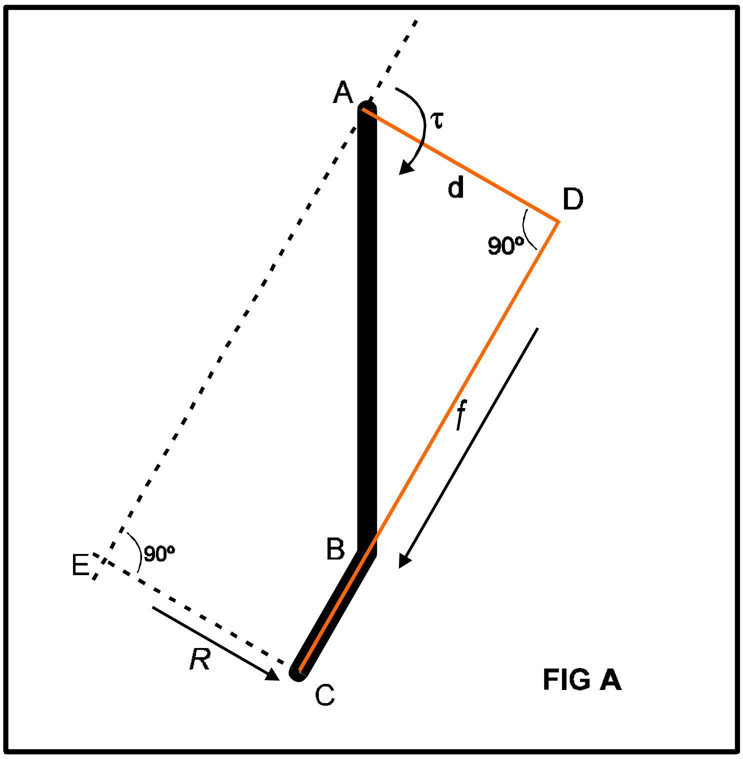

FIG A

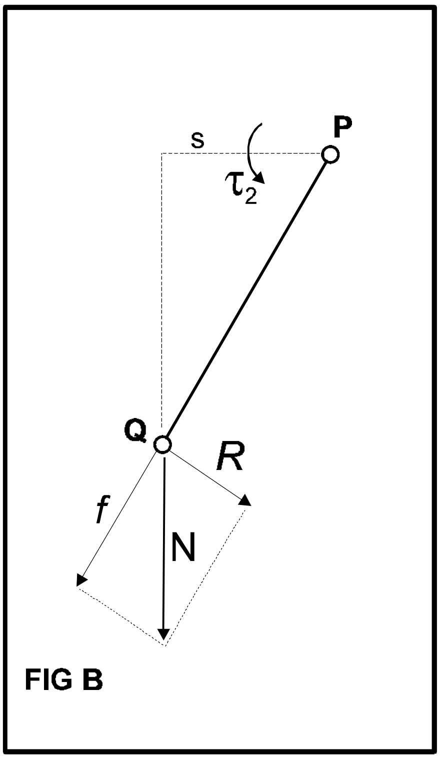

FIG B

Figure A shows the arm geometry **ABC**, pivot at A, stylus tip at C.

If the arm is rigid, it can be replaced by any physical geometry that maintains **C** relative to **A**. So it is convenient to regard the arm geometry as **ADBC**, where **AD** is perpendicular to **DBC**. The frictional drag on the diamond, shown ***f***,acts in the direction of the groove, and along the axis of the cantilever **BC**.
f acts at a perpendicular distance **AD** from the pivot **A**, producing a moment **t** (torque) about point **A**, where **t** = ***f*** **·d**. That is the skating force, that tends to thrust the pick-up towards the lable area of the record.

Within a small time frame, the system is in equilibrium (i.e., there is no overall motion of the arm about the point **A**), the groove wall reaction force ***R*** acting on the diamond must produce a torque equal and opposite to the effect of **t**.
R acts on **A** at a distance **EA**, producing a torque **-t** (counterclockwise) about **A**. This is why the stylus stays in the groove, despite the lack of antiskating force.

Figure B shows the forces on the cantilever, anchor point at **P**, diamond attached at **Q**.
The two forces on the diamond, friction ***f*** and groove-wall reaction ***R***, produce a nett force **N**. **N** acts at a perpendicular distance **s** on the cantilever anchor point to produce a torque $\mathbf{t_2} = \mathbf{N{\cdot}s}$.

The direction of $\mathbf{t_2}$ is counterclockwise, so in the absence of any anti-skating measures the cantilever will be deflected outwards toward the periphery of the record.

Antiskating force can only be applied - owing to practical considerations - at the arm pivot point, **A**. A counterclockwise torque, of magnitude **-t** , reduces the magnitude of **R** to zero. I.e., the groove reactionarly force exerted on the diamond by the 'left' groove wall is reduced or eliminated. In Figure B, as **R** becomes vanishingly small, so too does **N**, and the only force acting on the jewel is along the axis of the cantilever **PQ**.

If the offset angle **ÐABD** is made smaller, the distance **d** at which the monent of ***f*** acts, is also correspondingly reduced. In the extreme case of **ÐABD**=0°, **d** = 0, and ***f*** acts through **A**, producing zero moment or torque. There is no reactionary force exerted by the groove wall, and no skaing compensation is necessary (linear tracking arm).

STRAIGHT TONE ARMS:

Straigh tone arms used on some DJ turntables are NOT devoid of skating forces.

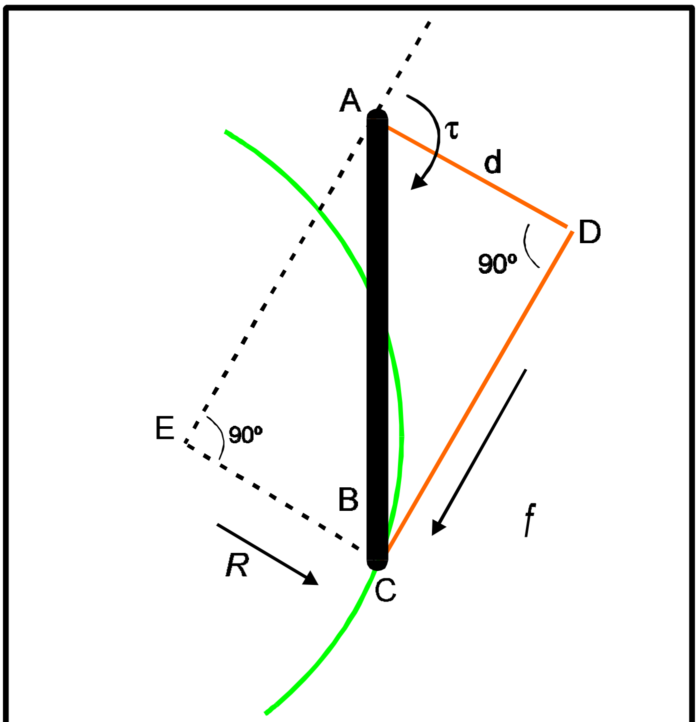

FIG C

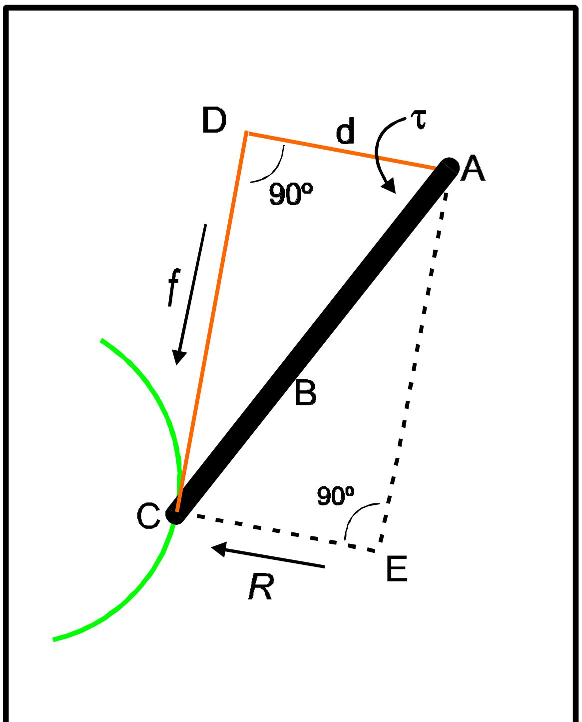

FIG D

Figure C shows a straight arm (no offset angle) **ABC** playing a groove shown in green.
Once again the frictional force, ***f***, acting on the diamond at **C** is tangential to the groove. Because the arm ABC is *not* tangential to the groove, ***f*** acts at a distance **d** on **A**, resulting in a torque about **A**. The is a corresponding reactionary force exerted by the groove wall, **R**.

This situation *cannot* easily be remedied by an externally applied anti-skating force:

Condider Figure D, angles slightly exaggerated for clarity.
The arm is now playing a groove of small radius. Again, the frictional force, ***f***, is tangential to the groove, but the tangent now passes at a distance, **d,** *on the other side* of **A**, producing a torque as before. This torque ***f*** **·d** is now counterclockwise, the groove reactionary force being reversed and acting inwards towards the label. Any antiskating compensation now would have to act inwardly.

Such an anti-skating mechanism that changes direction is prohibitively complicated. Since straight arm turntables are not compatible with low tracking error, low distortion, and minimised record and stylus wear, anti-skating measures are not implemented.