will not generally be constant, for instance, the instantaneous current due to the filling up of a condenser diminishes in strength as the potential of the condenser increases. Let, therefore, C be the current at any time t, then the moment of the deflecting couple is $bCMl$, where b is a constant depending on the galvanometer, M the magnetic intensity of each pole of the needle and l the distance between the poles. Hence the equation of motion is

$$mk^2.d\omega=bCMl.\,dt$$

But C can be considered constant for the short interval of time dt, so that $C.dt$ is the quantity of electricity, dQ, transmitted during the interval dt. Hence

$$mk^2.\,d\omega=bMl.\,dQ$$

Integrating and remembering that $Q=o$ when $\omega=o$, and writting Ω for ω

$$mk^2\Omega=bMlQ$$

But the work done on the needle is $\frac{mk^2\Omega^2}{2}$, hence

$$Q^2 \propto \text{ work done on needle.}$$

To show that $\sin^2\frac{\delta}{2}$ *is a measure of the work done by an instantaneous current on the needle of a galvanometer.*

The effect of an instantaneous current is, as seen above, to impress an initial angular velocity on the needle. During the motion, the forces acting on the needle are: the magnetic attraction of the Earth, (forming a couple,) the resistance of the air and the friction of the pivot. The last two forces will, however, be neglected and their effect allowed for by a subsequent correction.*

Let ω be the angular velocity at any time t, and θ the angle described from the position of equilibrium; the remaining letters having the same signification as in the previous paragraph. Then the equation of motion, obtained by taking moments about the pivot, is

$$mk^2\frac{d^2\theta}{dt^2}=-HMl\sin\theta$$

Multiplying both sides of this equation by $2\frac{d\theta}{dt}$, and integrating

$$mk^2\left\{\frac{d\theta}{dt}\right\}^2=2HMl\cos\theta+\text{constant.}$$

But, $\frac{d\theta}{dt}=o$, when $\theta=\delta$, the angle of deflection. Hence

$$mk^2\left\{\frac{d\theta}{dt}\right\}^2=2HMl(\cos\theta-\cos\delta)$$

*See § 180.