If $G'(u) \equiv 0$, then $G(u) = \text{cnst} = V(r)$ and <u>there</u> <u>is</u> <u>no</u> <u>force</u> <u>at</u> <u>all</u>! Differentiate again to get

$$(\dddot{u} + \dot{u}) / G'(u) - (\ddot{u} + u)\, G''(u)\, \dot{u} / (G'(u))^2 = 0$$ or

$$\boxed{(\dddot{u} + \dot{u})\, G'(u) = (\ddot{u} + u)\, G''(u)\, \dot{u}}$$

This is an equation for the orbit which does not involve any initial conditions

Now put $u = k H$. Since this is an orbit, we must have

$$k(\dddot{H} + \dot{H})\, G'(kH) = k^2 (\ddot{H} + H)\, \dot{H}\, G''(kH)$$ or

$$\boxed{(\dddot{H} + \dot{H}) = (\ddot{H} + H)\, \dot{H}\, k\, G''(kH) / G'(kH)}$$

which must be true for all k.

Putting $k = 1$ we get

$$(\dddot{H} + \dot{H}) = (\ddot{H} + H)\, \dot{H}\, G''(H) / G'(H).$$ Comparing we find

$$\boxed{0 = (\ddot{H} + H)\, \dot{H} \left[\frac{k\, G''(kH)}{G'(kH)} - \frac{G''(H)}{G'(H)} \right]}$$