3. MAGIC MOTOR

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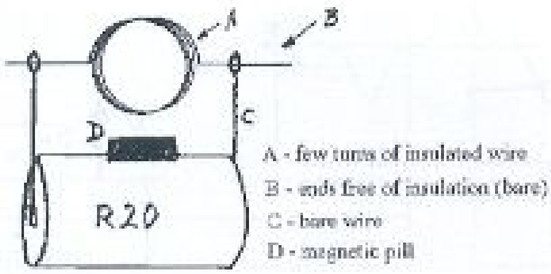
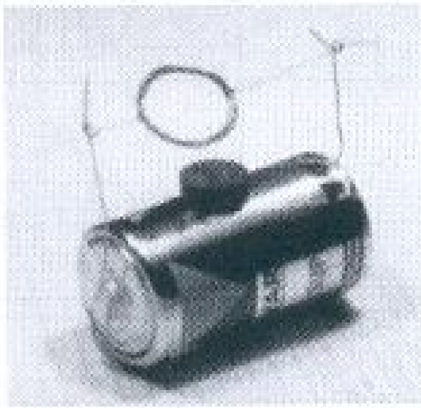
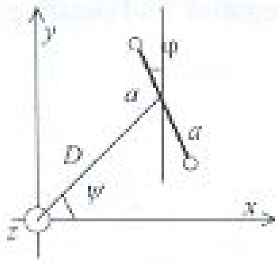


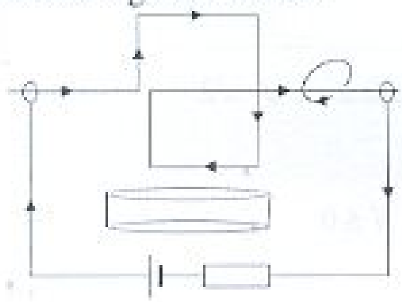


We have motor shown on the picture. In our model we consider rectangular frame as coil and take dipol magnetic field. Because inductivity of coil is small $L\sim 10^{-6}$ and E.M.F. caused by alternating of magnetic flux thruogh frame is negligable $\sim 10^{-5}$v. We consider buttery E.M.F. ξ and constant current $I=\xi/R$. The proposed aprouch is in good agreement with experiments. We get following data:



$\xi = 9$ V
$R_0 \approx 20\,\Omega$
$2a = 2$ cm
d = 0.2 mm
$A = 0.001\ \mathrm{T\cdot m^3}$
$k = 0.5$
$g = 9.8\ \mathrm{m/s^2}$
$D = 6$ cm

where R_0 is resistance of buttary, d - diameter of wire, k – index of friction between wires, g is free falling acceleration.



$$\vec{B} = A\frac{(\vec{\mu}\cdot\vec{r})\cdot\vec{r} - r^2\cdot\vec{\mu}}{r^5}$$

$\vec{r}(x, y, z)$

$\vec{\mu}(0,1,0)$

$\vec{F}_1 = I\cdot\vec{a}_1\times\vec{B}_1 \qquad \vec{a}_1(0,0,2a)$

$\vec{F}_2 = I\cdot\vec{a}_2\times\vec{B}_2 \qquad \vec{a}_2(0,0,-2a)$

where μ is dipole moment

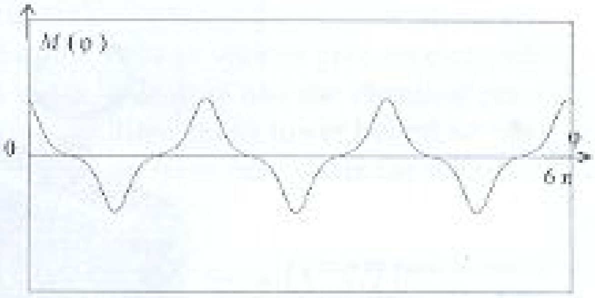
From magnetic field on frame with current act forces F_1 and F_2 they make moments M_1 and M_2 with respect to c.m. of frame and it begins to rotate.

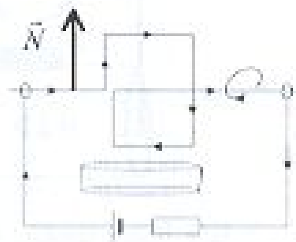
$$\vec{M}_1 = \vec{a}_1' \times \vec{F}_1 \qquad \vec{a}_1'(-a\sin\varphi, a\cos\varphi, 0)$$

$$\vec{M}_2 = \vec{a}_2' \times \vec{F}_2 \qquad \vec{a}_2'(a\sin\varphi, a\cos\varphi, 0)$$

$$\vec{M} = \vec{M}_1 + \vec{M}_2$$

From graph one can see that work of moment per one period is zero, it means that we have not source of energy but we have a friction, loosing of energy and rotating must fade.





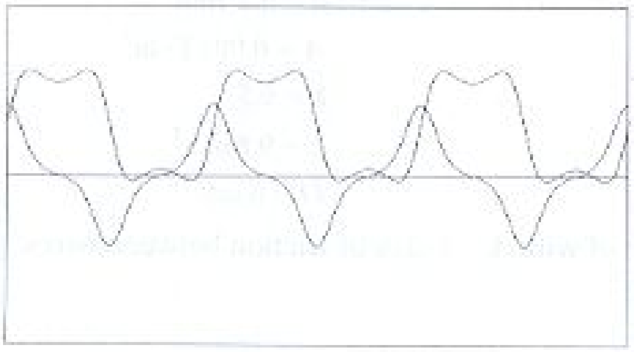
$$N_y = mg + F_{1y} + F_{2y}$$

where N_y is a reaction force between wires

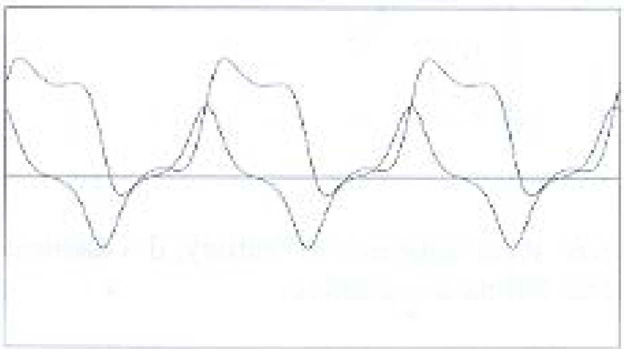
When $0 \geq N_y$, the coil jumps. Graph (1) shows us a picture when the magnet is shifted with respect to the symmetric axe of frame, graph (2) shows a picture when the magnetic pill is exactly under frame axe.

From graph (1) is clear that during disconnection is cut negative part of moment so we have positive work

From graph (2) is clear that with disconnection is cut equal negative and positive parts of moment so work is zero



graph.1 $\psi \neq \pi/2$



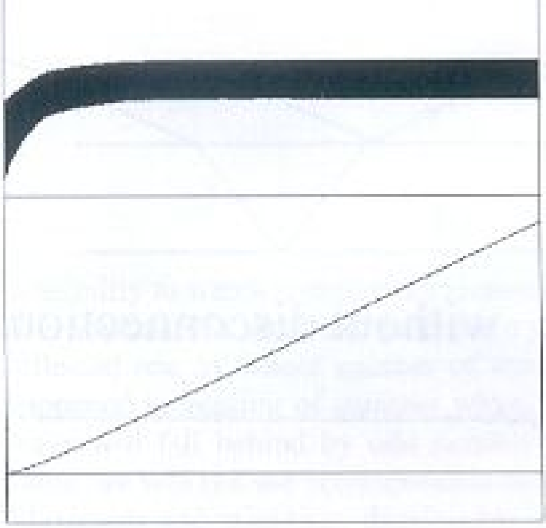
graph.2 $\psi = \pi/2$

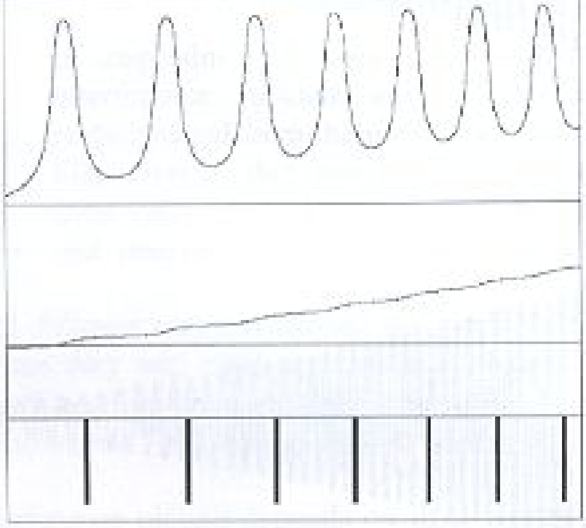
$$M_f = \begin{cases} kNd/2 & \dot{\varphi} \leq 0 \\ 0 & \dot{\varphi} = 0 \quad \text{or} \quad N \leq 0 \\ -kNd/2 & \dot{\varphi} \geq 0 \end{cases}$$

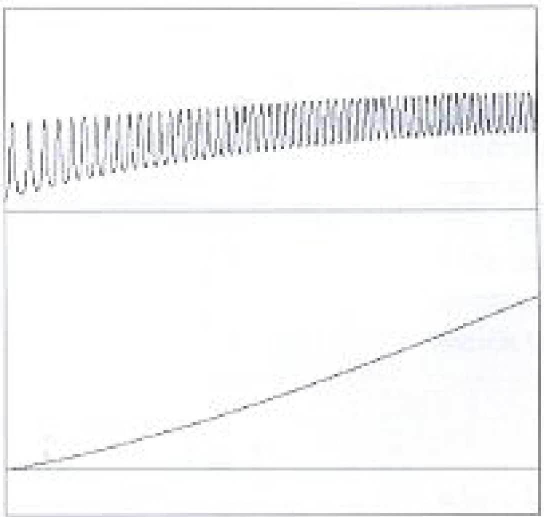
$$M_{af} = -\alpha\dot{\varphi}$$

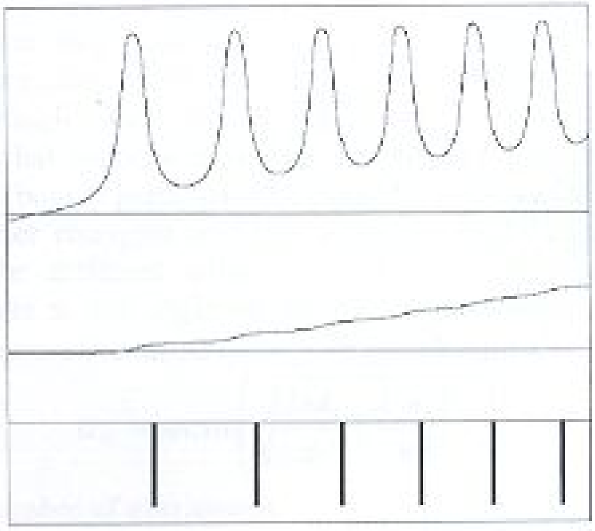
$$J\ddot{\varphi} = \vec{M}_1 + \vec{M}_2 + \vec{M}_f + \vec{M}_{af}$$

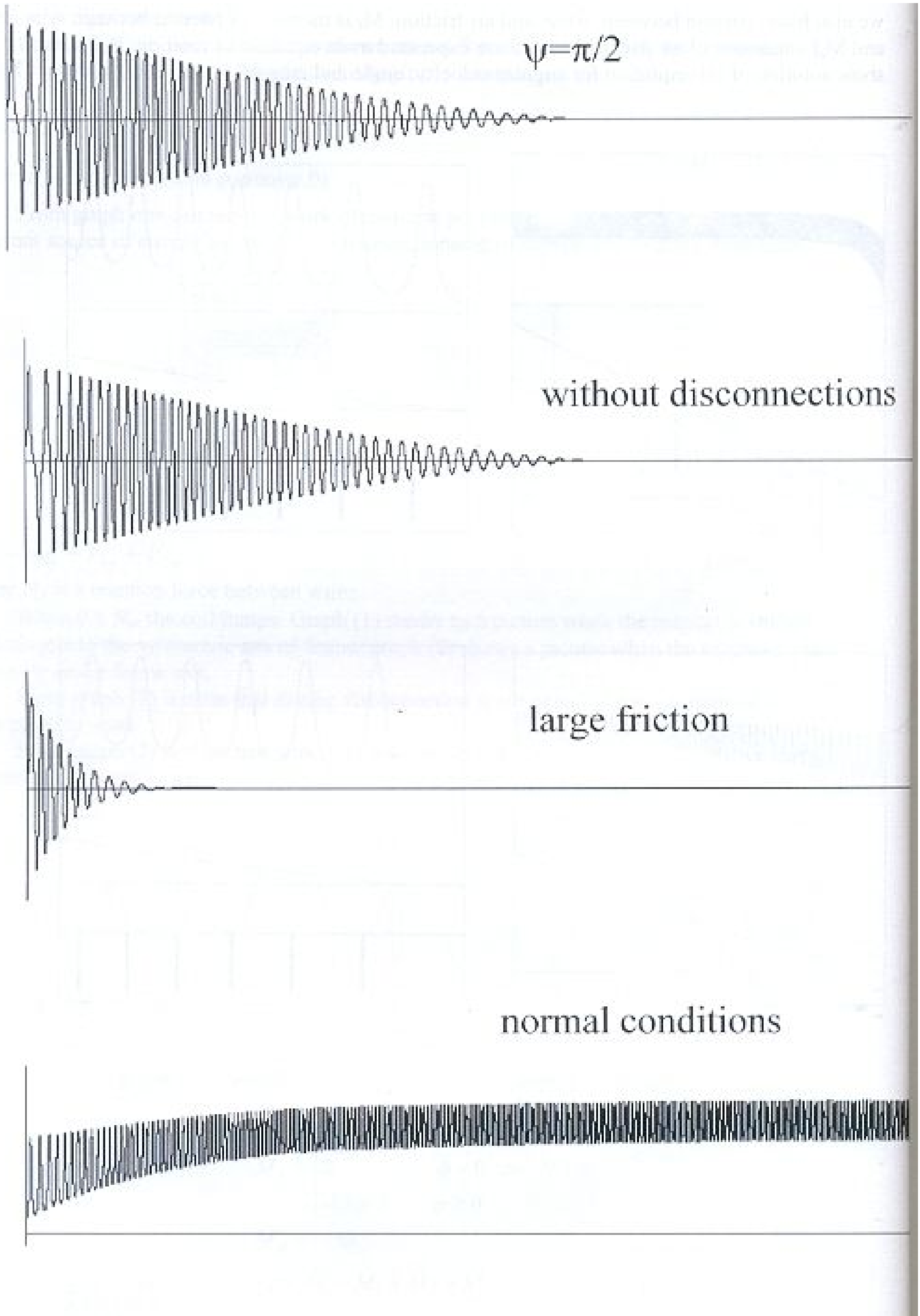
we also have friction between wires and air friction. M_f is moment of friction between wires and M_{af} – moment of air friction. Above are expressed main equation of rotation. Below we show solution of this equation for angular velocity, angle and current.










ψ=π/2
without disconnections
large friction
normal conditions