| $\label{eq:starses} \begin{array}{llllllllllllllllllllllllllllllllllll$ | Apparatus                     |                                       |
|---|-------------------------------|---------------------------------------|
|   | 1 DC power supply $016V/05$ A | 545<br>793<br>120<br>120<br>442<br>46 |

The frequency at which the amplitude of the oscillation is maximal is called the resonance frequency  $\omega_{\text{R}}$  (amplitude resonance). This is the case when the radicand in the denominator is minimal. By equating the derivative of the radicand with respect to  $\omega$  to zero the following relationship for the resonance frequency is found:

$$\omega_{\rm R} = \sqrt{\omega_0^2 - \frac{k^2}{2 J^2}} = \sqrt{\omega_0^2 - 2 \,\delta^2} \tag{VI}$$

with

ω<sub>0</sub>

L

$$=\sqrt{\frac{D}{J}}$$
 (natural frequency) (VII)

$$\delta = \frac{\kappa}{2 \cdot J}$$
 (damping constant) (VIII)

For the specific solution the following relationship can be used:

$$\varphi(t) = \varphi_0(\omega_{ex}) \cdot \sin(\omega_{ex} \cdot t - \phi) \tag{III}$$

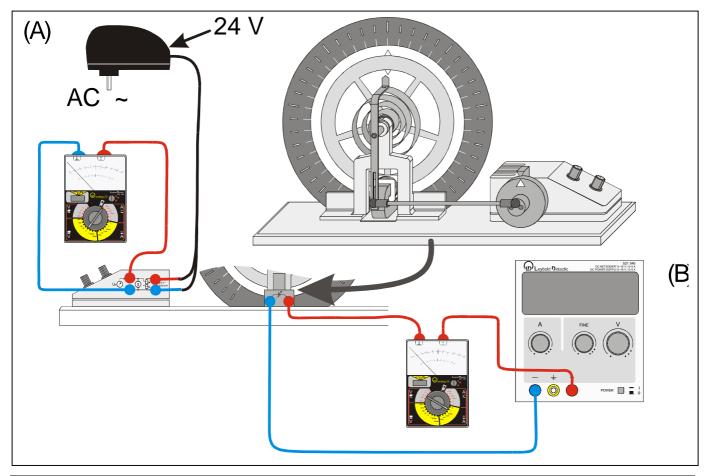
Substituting equation (III) in equation (II) gives after several trigonometric transformations the amplitude of the forced oscillation:

$$\varphi_0(\omega_{ex}) = \frac{M_0 / J}{\sqrt{(\omega_0 - \omega_{ex})^2 + \left(\frac{k}{J}\omega_{ex}\right)^2}}$$
(IV)

The lower the damping the less the resonance frequency differs from the natural frequency  $\omega_0$  and the larger is the amplitude. In the limit of disappearing damping  $(k \rightarrow 0)$  the amplitude at the resonance frequency  $(\omega_{ex} = \omega_0)$  would tend towards infinity (so called resonance catastrophe).

From equation (IV) follows that amplitude of the forced oscillation tends towards zero for very high frequencies. For very low frequencies ( $\omega \rightarrow 0$ ) the amplitude tends towards the value M<sub>0</sub>/J (which is not equal zero). The resonance curve is not symmetrical with respect to the resonance frequency  $\omega_R.$ 

Fig. 2: Schematic representation (wiring diagram) of the experimental setup: (A) exciter, (B) eddy current brake.



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