ANNALS of the ORADEA UNIVERSITY.
Fascicle of Management and Technological Engineering

THE INFLUENCE OF "GYROSCOPIC" EFFECT TO CENTRIFUGAL MOULDING MACHINES

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Abstract: The paper analyses the influence of throbs of the shaft and the influence of the liquid metal, during its moulding into the metallic mould, upon the functioning of the centrifugal moulding machines with horizontal axle of rotation.

1. INTRODUCTION

A very important issue that must be taken into consideration during the process of design and exploitation of centrifugal moulding machines, knowing the fact that the moulding shape is in a rotary motion, is the problem of the disturbing forces which encourage the appearance of vibrations (throbs) in the rotation system, an unwanted phenomenon which leads to a premature destruction of the bearings and also to the phonic pollution of the environment.

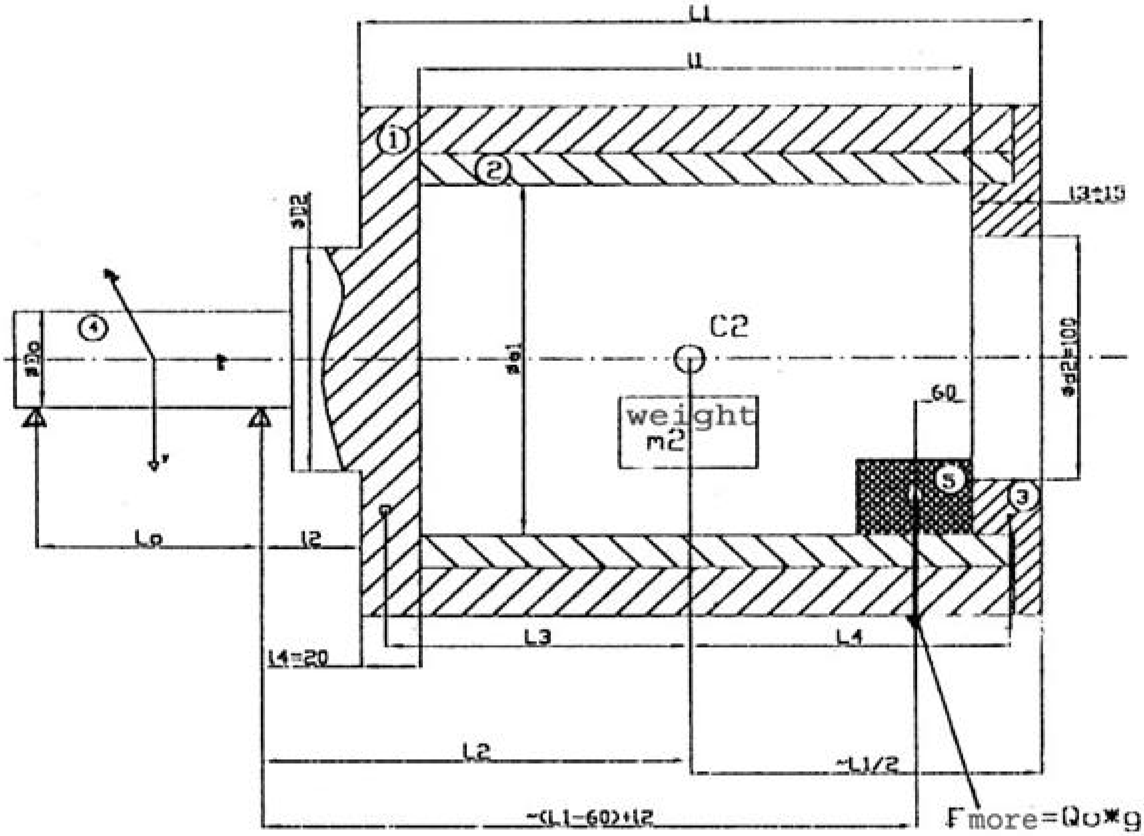

Fig.1. Scheme of horizontal centrifugal moulding machine. (1- shell support; 2 - shell; 3 - lid; 4 - shaft; 5 - disturbing mass).

If the problem of throbs caused by the unbalanced masses was solved through static balancing and, where it was the case, through dynamic balancing, less analyzed was the influence of throbs of the shaft as well as the influence of the liquid metal during its moulding into the metallic mould upon the working without vibrations of the centrifugal moulding machines.

We consider that the shell support – shell – lid ensemble as punctiform masses assembled on a double leaned horizontal shaft, specific to the centrifugal moulding machines, with horizontal axis of rotation (Fig. 1).

2. EXPERIMENTAL RESEARCHES

A more elaborate calculus must take into consideration the "gyroscopic" effect, as well as the "critical secondary speed", caused by the addition through moulding of a liquid metal quantity Q_0.

The effect of the gyroscopic couple disc (the ensemble shell support – shell – lid) during the rotation motion of the shaft, produces different effects from those afferent to the disc taken as a punctiform mass.

In addition to the facts emphasized in the previous analysis, where the mass inertia moment $Iz_{(2)}$ was taken into consideration too, the following aspect is worth estimating: - during the rotation motion, the disc gets out of its initial symmetry plan, and the shaft will have a variable inclination angle near the disc. This happens in this case, where the disc is placed in a console (Fig. 2).

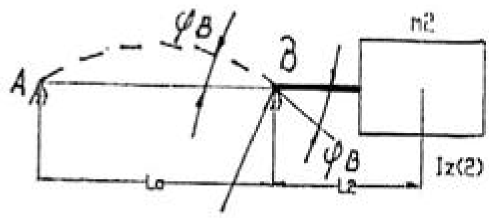

Fig. 2

In order to simplify the calculations, there is considered the effect of finite rigidity of the shaft AB (between bearings) estimated through the agency of rotation $\varphi_{B.}$ Thus, the portion situated in the console will be able to be considered as being integrated in the level of section B, but with the shaft's axis inclined with angle φ_B (Fig. 3).

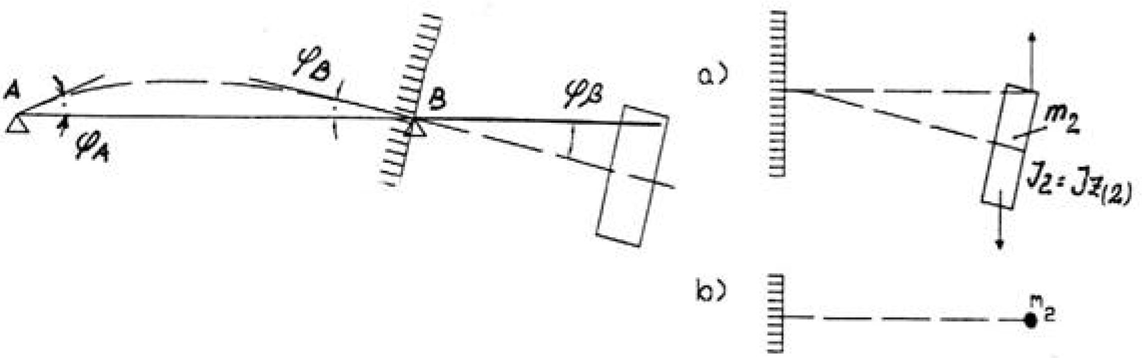

Fig. 3.

Leaving aside this initial inclination in the following calculations, we can demonstrate the supplementary influence of the gyroscopic couple effect over the deformation of the area of length L_2 (situated in the console).

During the rotation there appears a pair of inertia forces (the gyroscopic couple) which tends to straighten the shaft, Fig. 4a, which equates to an increase of the shaft's rigidity and also to the own throb (different from the solution with mass m_2 in Fig. 1)

To show this, we consider the disc from Fig. 5, which is in a rotation motion with the angular speed ω_0.

$$\omega_0 = \frac{2\pi \cdot n}{60} \quad [rot/s] = [s^{-1}] \tag{1}$$

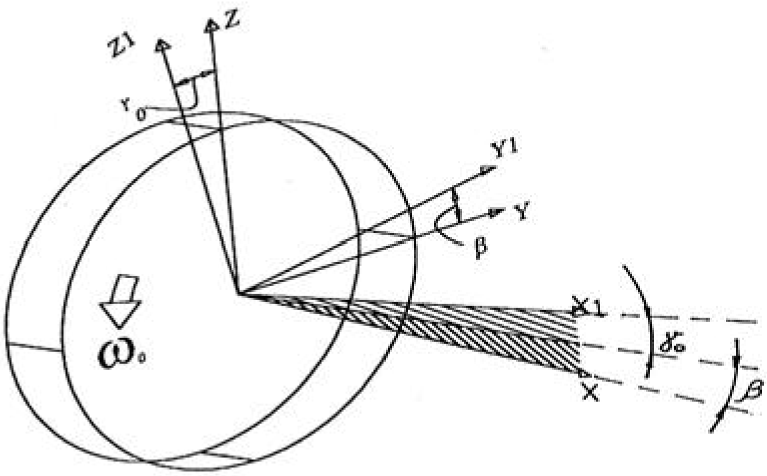

Fig. 5.

The initial system of reference xOyz, during the rotation motion becomes $x_1Oy_1z_1$. We consider the disc perfectly centered, therefore having its centre of weight on the shaft's axis.

We can consider:
- the mass inertia moment in comparison with the axis $Ox \approx Ox_1$
- the mass inertia moment in comparison with the axis Oy_1 and Oz_1
- η- the projection of the linear movement of the centre of weight (of mass) C_2 on the fixed axis Oy;
- ξ- the projection of the linear movement of the centre of weight C_2 on the fixed axis Oz.

From the calculations we obtain two equations of the own throbs, from which we keep in mind the one according to the situation when upon the shaft, operate supplementary disturbing effects (the same throb as the one afferent to the shaft's critical revolution), that is:

$$\left(\frac{p}{p_0}\right)^4 \frac{3I_1}{4m_2L_2^2}\left(1+\frac{I_0\omega_0}{I_1p}\right) - \left(\frac{p}{p_0}\right)^2 \left[1+\frac{3I_1}{m_2L_2^2}\left(1+\frac{I_0\omega_0}{I_1p}\right)\right] + 1 = 0 \ ; \tag{2}$$

where:
- p_0- the shaft's throb without a gyroscopic effect;
- p- the own throb (throbs) of the system, with the gyroscopic effect;

We observe that at the same time with the increase of the relation I_1/I_0 there grows as well as the modification's influence of the given system's own throbs.

3. CONCLUSIONS

In order to avoid the premature destruction of the shaft's bearings, it is necessary that when choosing them, we keep in mind the shaft's rotation in a transversal plane, under the centrifugal ensemble mass effect, as well as the gyroscopic couple effect.

After experimental researches, it was found that for the centrifugal moulding machine's normal working, the movement of the centrifugal ensemble in horizontal plane in front of the mass centre, as a result of the shaft's rotation in bearings, must not overtaken the value of 0,002m.

REFERENCES

[1]. Jiman, V. – *Cercetari privind turnarea centrifugala cu plan de separatie a pieselor din fonta, cu profil de revolutie.* Ph.D. Thesis, University Transilvania of Brasov, 2000.