2. It was shown that in the examined variants, the higher energy capacity $e_m = 0.865$ is obtained in the case of the AME whose shell and ring materials are identical and which has the highest specific strength (organic plastic).

3. For the AME without the force interaction between the shell and the ring, the specific energy capacity may be near unity as a result of the reduction of the mass of the shell.

**LITERATURE CITED**


**CALCULATION OF THE CHORD FLYWHEEL**

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The main subject of the investigations into mechanical energy storers at the present stage is the development of methods of calculating these devices and also investigations aimed at developing the optimum design of the flywheel. According to the authors of [1, 2], the so-called chord flywheel is one of the most promising devices. The main energy-absorbing element of the chord flywheel is the ring with circumferential reinforcement which is wound with chords. The chord flywheels are preferred owing to the fact that their manufacturing technology is comparatively simple and their design makes it possible to solve the problems of transfer of torque and prevents to a certain degree the premature failure of the ring in the radial direction.

The present work is concerned with the development of a method of calculating chord-like mechanical energy storers and evaluating their energy parameters.

1. Winding of the reinforcing filaments along the chords in the disk plane is geodesic. It is well known that the winding law is $r \sin \varphi = r_0$, where $\varphi$ is the winding angle, $r_0$ is the radius of the polar aperture, and the tension of the filaments is determined from the equation [3]

$$T = T_R + \frac{\rho F (R^2 - r^2)}{2} \left(1 - \frac{r^2}{R^2} + r_0^2 \ln \frac{1 - r_0^2}{r^2 - r_0^2}\right).$$

In Eq. (1) $\rho$ is the density of the chord material; $T_R$, tension of the chord at the periphery of the flywheel; and $F$, cross-sectional area of the chord. The equation indicates that at the polar aperture at $r = r_0$, the tension in the filament becomes equal to infinity and the theoretical value of the energy capacity of the chord flywheel should be equal to zero. This main problem can be overcome if it is taken into account that in loading the filament is deformed and occupies a new position which differs from the straight position.

We shall examine a disk formed by chord winding. We shall write the equations of equilibrium of the deformed filament in the projections of the forces on the normal and tangent...
Fig. 1. Calculation diagram of the chord flywheel.

to the filament (Fig. 1):

$$\frac{dT^*}{dr^*} \cos \varphi^* + \rho F \omega^2 r^* \cos \varphi^* - q \sin \varphi^* = 0;$$

$$\frac{T^*}{r^*} \frac{d}{dr^*} (r^* \sin \varphi^*) + \rho F \omega^2 r^* \sin \varphi^* + q \cos \varphi^* = 0,$$

where \( q \) is the shear reinforcement in the mesh per unit length of the filament; \( \omega \) is the angular speed of rotation of the flywheel.

The relationship between the strained initial state of the filaments can be determined assuming that their strains are finite [4]. The principal relationships for the finite strains in the case in which the filament in the initial and strained states is positioned in the plane of rotation may be written in the form

$$\sin \varphi^* = \frac{1 + \varepsilon_2}{1 + \varepsilon_f} \sin \varphi; \quad \cos \varphi^* = \frac{1 + \varepsilon_1}{1 + \varepsilon_f} \cos \varphi;$$

$$r^* = (1 + \varepsilon_1) r; \quad \frac{d \varphi^*}{dr} = \varepsilon_1 - \varepsilon_2;$$

$$(1 + \varepsilon_f)^2 = (1 + \varepsilon_1)^2 \cos^2 \varphi + (1 + \varepsilon_2)^2 \sin^2 \varphi,$$

where \( \varepsilon_f \) is the strain in the filament, and \( \varepsilon_1 \) and \( \varepsilon_2 \) are the strains in the chord disk in the radial and circumferential directions, respectively.

Substituting Eqs. (3) into equations of equilibrium of the strained filament (2), and solving the resultant equation in respect of the strains, we obtain

$$\frac{d \varepsilon_1}{d r} = \frac{1}{c d (a - b - ce)}; \quad \frac{d \varepsilon_2}{d r} = \frac{\varepsilon_1 - \varepsilon_2}{r},$$

where

$$a = \varepsilon_f \sin^2 \varphi (\frac{1 + \varepsilon_2}{1 + \varepsilon_1})^2 \left[ \frac{1 + 2 \varepsilon_1 - \varepsilon_2}{r (1 + \varepsilon_2)} + \frac{d \sin \varphi}{dr} \frac{1}{\sin \varphi} \right];$$

$$b = \frac{\rho \omega^2 r}{E} \frac{1 + \varepsilon_2}{1 + \varepsilon_1} (1 + \varepsilon_f)^2; \quad c = \cos^2 \varphi + \sin^2 \varphi \frac{\varepsilon_f}{1 + \varepsilon_f} \left( \frac{1 + \varepsilon_2}{1 + \varepsilon_1} \right)^2;$$

$$d = (1 + \varepsilon_2) \cos^2 \varphi;$$

$$e = \frac{(1 + \varepsilon_1)^2}{2} \frac{d \cos^2 \varphi}{dr} + (1 + \varepsilon_2) \sin^2 \varphi \frac{(\varepsilon_1 - \varepsilon_2)}{r} + \frac{(1 + \varepsilon_2)^2}{2} \frac{d \sin^2 \varphi}{dr}.$$

The tension of the filament is determined from \( T = E \varepsilon_f f \), where

$$\varepsilon_f = [(1 + \varepsilon_1)^2 \cos^2 \varphi + (1 + \varepsilon_2)^2 \sin^2 \varphi]^{1/2} - 1.$$  

Thus, the strained state of the chord flywheel is determined completely by Eqs. (4), (5) for the corresponding boundary conditions in respect of \( \varepsilon_1 \) and \( \varepsilon_2 \). The shear force may be determined from Eqs. (2).