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USAGE RATIO OF FILLET PLANETARY TRANSMITTER COMPARED TO CYLINDRICAL PLANETARY TRANSMITTER

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ABSTRACT
In the document is treated planetary transmitter type 1A1 with screwed hyperboloid gears. In the beginning is given the diapason of transmission relation, afterwards for different beveled angles of gears, is analyzed usage ratio taking into consideration friction too. Usage ratio is defined in experimental way also. Given results for filled hyperboloid planetary transmitter are compared with those of cylindrical planetary transmitter.

1. PREFACE
Cylindrical Planetary Transmitters have an important application in gear transmitters and in many technical branches, especially during huge power transmission, because there is used a power division. A simple planetary transmitter type 1*AI* is presented in fig.1.

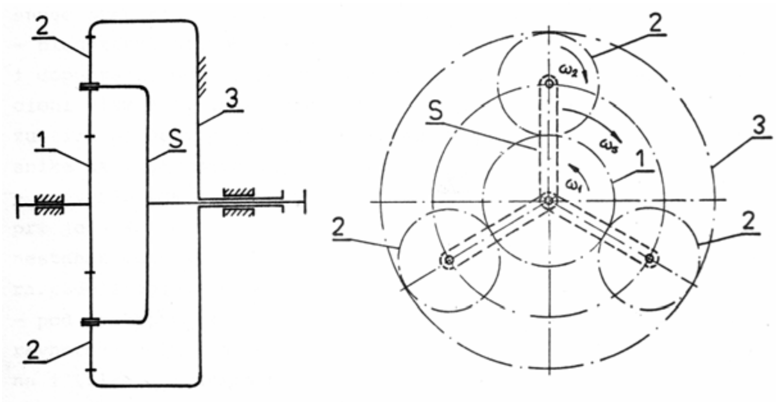

Figure 1. Simple planetary transmitter 1AI scheme with static central gear 3

For cylindrical planetary transmitter as in fig. 1., transmission relation is defined by:

$$i_{1S} = 1 - i_{13} \qquad \text{... (1.1)}$$

Realization of transmission relation diagram is $2{,}5 \le i_{1S} \le 12{,}5$.

At cylindrical planetary transmitter beveled angle of gear collateral lines is the same. Planetary transmitter with different beveled angles of collateral lines of gears with intersected axes, are called filled planetary transmitter.

For filled planetary transmitter as in fig. 1., transmission relation is defined by:

$$i_{1S} = 1 - \frac{d_3 \cos\beta_3}{d_1 \cos\beta_1} \qquad \text{... (1.2)}$$

Intersection angle of rotating axes is defined by:

$$\Sigma = (\beta_1 - \beta_3)/2 = \beta_1 + \beta_2 = -(\beta_2 + \beta_3) \qquad \text{... (1.3)}$$

While beveled angle of ....lines for planetary gears is defined by:

$$\beta_2 = -(\beta_1 + \beta_3)/2 \qquad \text{... (1.4)}$$

For the case of filled planetary transmitter, with huge transmission relation, is taken $|\beta_1| > |\beta_3|$, while for the same central gear diameter with internal teeth and equal transmissions relation, we get higher central gear diameter with external teeth than at cylindrical planetary transmitter (fig. 2.) and with this we get higher transmission capabilities. He factor for diameter increase as given by:

$$F_R = \cos\beta_3 / \cos\beta_1 \qquad \text{... (1.5)}$$

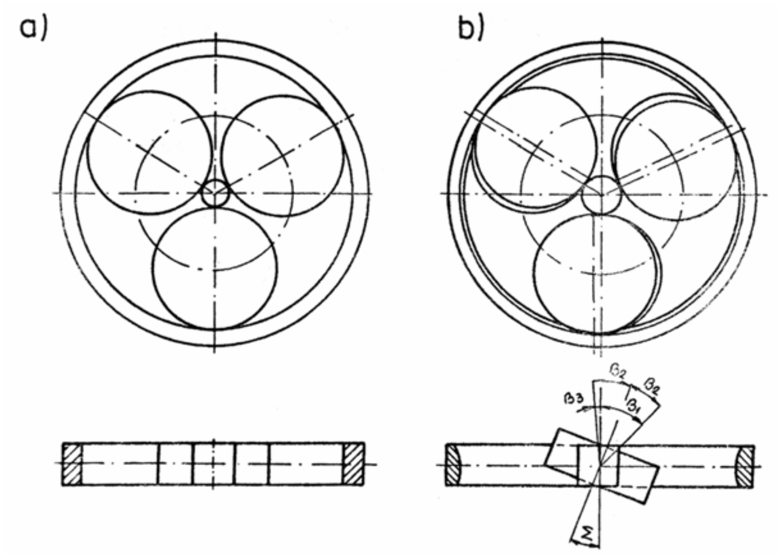

Figure 2. Increase of relation of geometric dimensions of filled planetary transmitter compared to cylindrical planetary transmitter with transmission report i_{1S} = 11.

In this work a special case will be treated for filled planetary transmitter, where beveled angles of collateral lines of teeth are: $\beta_1 = -2\beta_2$, $\beta_3 = 0$ d and intersection angles of rotating axes $\Sigma = -\beta_2$, for transmission relation $i_{1S} = 11$ (fig. 3.). For this transmitter, usage ratio will be analyzed and will be compared with usage ratio of cylindrical planetary transmitter.

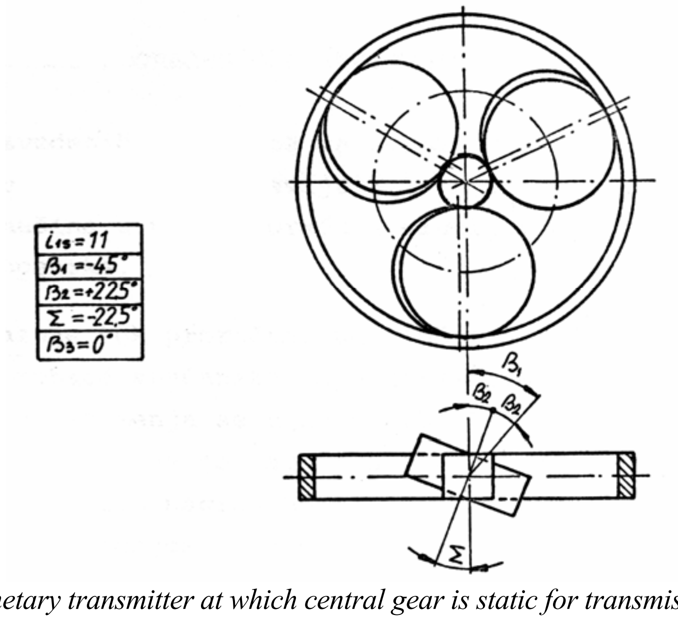

Figure 3. Filled planetary transmitter at which central gear is static for transmission relation i_{1S} = 11

2. USAGE RATIO FOR PLANETARY TRANSMITTER

Cylindrical planetary transmitter as in fig. 1., are known as transmitters with high usage ratio. Usage ratio for the case of holder of static planetars is given by:

$$\eta_{13} = \eta_{12A} \cdot \eta_{23I} \cdot \eta_l \qquad \text{... (2.1)}$$

Usage ratio of cylindrical planetary transmitter as in fig. 1., is given by:

$$\eta_{1S} = \frac{1 - i_{13}\eta_{13}}{1 - i_{13}} \qquad \text{... (2.2)}$$

Usage ratio of filled planetary transmitter as in fig. 3., also is given by (2.2):

At this transmitters additional sliding movement For this reason, usage ratio η_{13}, respectively usage ratios of fillet external mesh η_{12A} and internal η_{23I}, is given by:

$$\eta_{12A} = \frac{\cos(\beta_{w2A} - \rho_{vA})\cos\beta_{w1}}{\cos(\beta_{w1} - \rho_{vA})\cos\beta_{w2A}} \qquad \text{... (2.3)}$$

and

$$\eta_{23I} = \frac{\cos\rho_{vI}\cos\beta_{w2I}}{\cos(\beta_{w2I} - \rho_{vI})} \qquad \text{... (2.4)}$$

Usage ratio of cylindrical planetary transmitter as in fig. 3., based on (2.2), (2.3) and (2.4) depending on beveled angles of collateral lines of teeth of planetars is presented in table 1. and graphically in fig. 4.

Table 1. Usage ratio η_{13} and η_{1S} depending from angles β_2 for μ_v = const.

Transmiss-ion relation i_{1S}	Beveled angles of collateral lines of teeth β_2	Usage ratio for external filled mesh η_{12A}	Usage ratio for internal filled mesh η_{12A}	Usage ratio of transmitter for holder of static planetars η_{13}	Usage ratio of filled planetary transmitter η_{1S}
-	°	%	%	%	%
11.3077	0	99.00	99.00	97.51	97.73
	8.844257	98.86	98.92	97.30	97.54
	12.977384	98.25	98.41	96.20	96.54
	16.100005	97.72	98.02	95.31	95.72
	18.724228	97.21	97.69	94.49	94.98

μ_v = 0,07; η_l = 0,995; $\eta_{12} = \eta_{23}$ = 0,99.

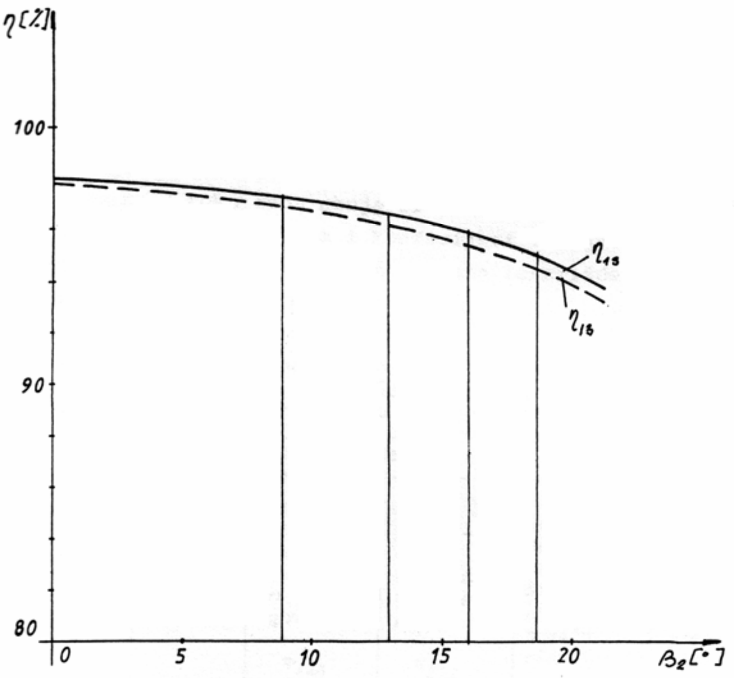

Figure 4. Dependence of usage ratios η_{13} and η_{1S} from angle β_2.

Also here is treated the case when friction coefficient is changed respectively friction angle ρ_v for β_2 = const.

In Table 2. are given the values of usage ratio η_{13} and η_{1S} depending from friction coefficient β_2 = const, while in fig. 5. graphic expression.

Table 2. Values of usage ratio η_{13} and η_{1S} depending from friction coefficient for β_2=const.

Transmission relation i_{1S}	Friction coefficient μ_v	Friction angle ρ_v	Usage ratio for external filled mesh η_{12A}	Usage ratio for internal filled mesh η_{23I}	Usage ratio of tran-smitter for holder of static planetars η_{13}	Usage ratio of filled planetary transmitter η_{1S}
-	-	°	%	%	%	%
11.3077	0.05	2.862405	98.74	98.86	97.13	97.38
	0.06	3.433630	98.49	98.63	96.65	96.95
	0.07	4.004170	98.25	98.41	96.20	96.54
	0.08	4.573920	98.00	98.19	95.75	96.13

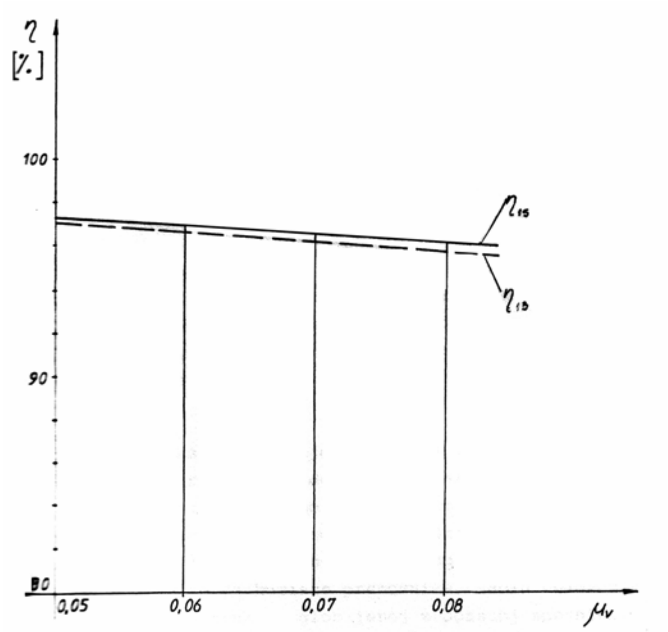

Fig. 5. Dependence of usage ratio η_{13} and η_{1S} from fricion koeficient μ_v.

3. CONCLUSIONS

Based on the given results we can conclude that:

- Usage ratio η_{1S} is higher than usage ratio η_{13}, with increase of angle β_2 respectively intersection angle Σ, usage ration η_{1S} is decreased;
- Usage ratio η_{1S} respectively η_{13} is decreased with increase of friction coefficient;
- Usage ratio of filled planetary transmitter is lower than usage ratio of cylindrical planetary transmitter.

4. REFERENCES

[1] Ibrahimi, N.: *Prilog istraživanju mogućnosti razvoja planetarnih prenosnika*, Doktorska disertacija, Priština, 1987.

[2] Schubert, F.: *Planetengetriebe mit verschwenkten Planetenradachsen*, Disertation Universität Stu-ttgart, 1983, Bericht, Nr. 66, des Instituts für Maschinenkonstruktion und Getrieben der Universi-tät Stuttgart.

[3] Langenbeck, K.: *Deutsche Patentschrift 2511973: Planetenschraubgetriebe* (1977).