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EXPERIMENTAL DETERMINATION OF LOADING ON POINTS EPICENTROID CYCLOIDAL GEARING OF ORBITAL HYDROMOTOR

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The analysis of existent methodologies of experimental determination of the normal loading is executed in epicentroid hooking. Description of the worked out methodology and the brought results over of experimental research of distribution of loading is given in hooking. Comparison of results of theoretical and experimental researches is given.

Key words: orbital hydromotor, girotor cycloid giaring, loading ability.

Entry. Orbital hydromotors behave to the cog-wheel machines of the internal hooking, they find all more wide application in different industries of industry and agriculture. By a basic working element formative the reserved volumes of working chambers, in orbital hydromotors there is epicentroid cycloid hooking. In such hooking the profiles of indents of one of gear-wheels are outlined by equally remote of epi- or gipotrohoid, and by the attended arc of circle. Problem. In epicentroid cycloid hooking must simultaneously be in a contact the indents located for one of parties of line of centers, however in practice, in connection with inevitable errors at making, it is never arrived at. Theoretical researches of loading ability of out of the center of the cycloid hooking showed that to promote it loading ability maybe by adjustment of theoretical profiles of indents on insignificant, one order with resilient deformations [5,8].

Aim of experimental research. A primary purpose during realization of experiments was: it is verification got in theory in works [6,8] level of pressure of liquid necessary for the rolling hooking; it is experimental research of law of distribution of the normal loading among indents then rolling hooking.

State of question. First experimental research of distribution of loading among indents in the out of the center hooking was executed at research of planetary reducing gear [4]. This method was used and by other authors at research of distribution of loading among indents in the marked reducing gears [3]. Methodology of realization of experiment is shortly taken to the following [4].The normal loading, operating on trickles, cause in their axes of tension of bend. These the tension register oneself by means of resistors. On the size of tensions in the axes of trickles judge about the normal loading in indents. The axes of trickles are executed so that their ends pass through opening in flange and come forward from his exteriority. On the axes of trickles flat is executed, on that тензометри is glued on. In the process of measuring of plane of лисок orient, labouring for maximal напруг in the axes of trickles. This tension arrives at a maximum, when the plane of лиски is perpendicular to the operating normal loading. On the butt end of axis trickles are executed.The axes of slots are located strictly athwart to the plane of

flat. When tension in the axes of trickles maximal, slots on their butt ends are situated in direction of action of the normal loading, id est specify on position of pole of hooking. Thus, a connection is established between the sizes of the normal loading and position of pole of hooking. To the basic lacks of the considered method of determination of the normal loading it is possible to take the following.
Impossibility of determination of the normal loading is in a dynamics. Presence of plenty of sensors. An origin of the additional tensions twisting is during the orientation of axes of trickles on-loading, and thus, and errors in measuring. If the orientation of axes of trickles is executed no-load, their position is controlled by sight by means of limbs, that also does not eliminate additional errors in measuring. Second method of determination of the normal loading in epicicloid hooking worked out in relation to an orbital hydromotor [1]. It consists in measuring of крутного moment on a cylindrical indent, the tailpress of that is shown out outside hydromotor. The end of tailpress of cylindrical indent of the hydromotor shown out outside is fastened motionlessly, on it of tensometer of resistance is glued on. During work of hydromotor on cylindrical indents, due to the presence of forces of friction in their contact, there is a twisting moment that causes deformation of twisting in the tailpress of cylindrical tooth. On the size of this deformation set the size of the normal loading on an indent. In connection with that the coefficient of friction in the contact of indents depends on speed of skidding of profiles, that for the different phases of hooking changes in wide limits, then this method is also inexact.
Methodology of realization of experiment. With the aim of removal of lacks of the considered methods there was the worked out methodology of measuring of the normal loading and special sensor of efforts, the testimonies of that do not depend on direction of action of the normal loading and speed of skidding of profiles [2] .
On rice. a 1 brought construction over of the marked sensor. Cylindrical empty roller 1 has boring into that a cylindrical bar is fastened 4, that has flat, on that tensoresistors is glued on 3. Bar 4 fastened to the internal opening of cupwashers 2 by means of nut 5, it is possible that to regulate effort of stretch of bar. From the right side of bar 4 a square tailpress is executed. At screwing up of nut a 5 sensor is fastened for this tailpress that prevents the rollup of bar 4. Cup washers pressed in boring on the butt ends of roller. The leadingout of explorers comes true through opening in the left part of bar 4. After pressed of cup washers a sensor, with the aim of maintenance of it cylindrical form, was ground in by means of special the tool for grinding in to the necessity A sensor works thus. A sensor takes place instead of one of cylindrical indents. At the contact of the united tooth with a sensor, last, in force of diminished inflexibilities near-by butt ends, tests the different on length grounds of contact resilient pin deformations. Thus at the edges of sensor pin deformation minimum, and deformation of bend is maximal. Deformations of bend near-by the butt ends of sensor are passed to the cup washers, as a result there is their "thrusting" out, that causes the stretch of the bar hardly connected with them 4 and glued on it On the aim of indemnification of influence of deformation of bend of bar 4, and also temperature changes, was included on a bridge chart. Resistors was glued on directly on a bar 4 sensors, and

resistors, that indemnifications of temperature - on the bar, placed in contiguous with a sensor empty cylindrical tooth that is in equal temperature terms, thus, deformation of the last bar was eliminated.

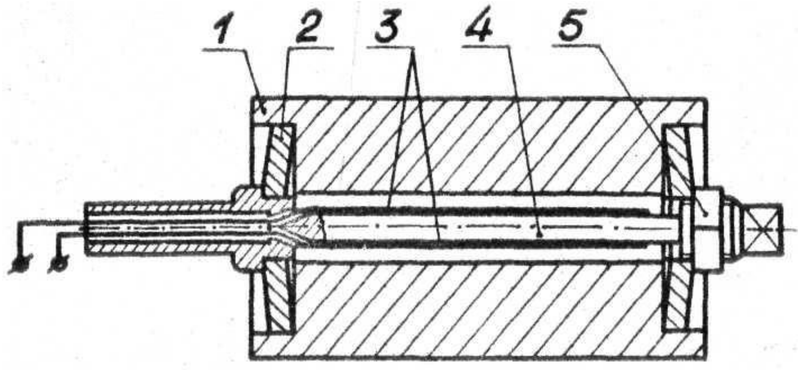

Fig. 1. Sensor of efforts

The construction of experimental hydromotor is shown on rice. 2. Rotor 1 included in hooking with cylindrical indents 2 stator 3. A rotor cooperates the butt-end surfaces with a lid 4 and by a corps 26. Lid 4 and stator 3 hardly connected with a corps 26 by means of screw-bolts 5. Eccentric person billow 15 set in a corps 26 on ball-bearings 24. The eccentric neck of this billow cooperates with a rotor 1 through bearing 28. From the axial moving an eccentric person billow is contained by a stop by a ring. 27. In a corps 26 axial channels are executed 25, the amount of that equals the number of cavities of indents of stator. Distribution of liquid comes true by means of flat distributor 13. A flat distributor to the internal boring unites with the external holder of bearing 14. Internal holder of bearing 14 reported with a hob 21, that can return in relation to a post 23, to press in the butt end of eccentric person billow 15. A management a flat distributor comes true by means of the special hydraulic strengthener of twisting moment 16, that in turn is managed a command hydromotor 19. Eccentric person billow 15 was shown out outside hydraulic booster, and on the end of вала 15 to press a gear wheel 17, that serves for dragging of ribbon in the cassette of oscillograph.

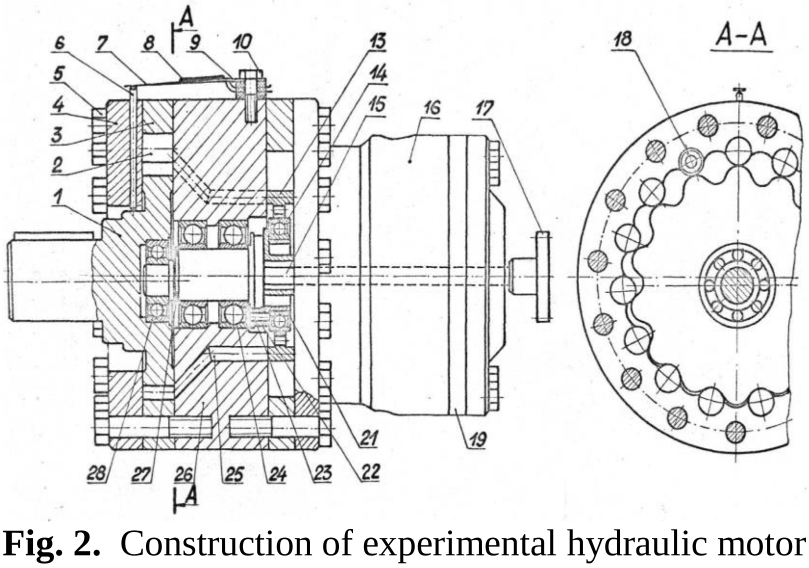

Fig. 2. Construction of experimental hydraulic motor

During work of hydromotor cylindrical indents, and, thus, and sensor of efforts 18 провертаються, that results in the rollup of explorers that connect a sensor with a tensometric strengthener. For the exception of rollup and break of specified explorers, a hydromotor worked in the repeatedly reversible mode. At such mode of operations of hydromotor it was succeeded to eliminate applications of trolley-poles, that, as known, cause additional errors at measuring

Basic results of experimental research. Gear-wheels were prospected with next geometrical parameters: number of cylindrical indents of stator of $z_ц$ = 15; number of indents of rotor of $z_т$ = 14; an excentricity of toothed pair of e = = is a 3,5 mm; coefficient of the позаецентроєдності hooking of К = 1,2; a radius of cylindrical indents of $r_ц$ = is a 7 mm; a width of toothed pair of h = is a 16 mm Cylindrical indents made from steel of ШХ15 with next heat treatment to hardness of HRC 62 - 64. The roughness of surfaces of cylindrical indents after their polishing answered Ra 0,32-0,63. The indents of rotors were processed on the machine for production of teeths. The roughness of their surfaces answered Ra 1,25-2,5. Choice of material of rotors and setting of it previous heat treatment it took place, going out hardness of indents in a period exploitation of hooking, that was accepted by even 60 HRC. For the achievement of maximal loading ability of hooking previous heat treatment of material of indents was appointed thus, that limit of pin endurance of active surfaces of indents in a period exploitation of hooking equaled possible pin tension in a period his At hardness of indents in a period exploitation of hooking of HRC 60 - 62, in accordance with GOST 21354-75, that answers the base number of cycles of loading limit of pin endurance of active surfaces of indents of $\sigma_{H\lim} = 23H_{HRC} = 1380$MPa. Limit of fluidity at the stretch of material of indents of rotor before their rolling $\sigma_T = 0{,}323\sigma_{H\lim} = 452$MPa. Such limit of fluidity can be отримана, for example, at the improvement of steel of 20X. This steel and was select for making of rotors. For researches two rotors were made. Calculated on methodology driven to work [8] at pin tension of $\sigma_{H\lim} = \sigma_{HP\max} = 1380$MPa size of pressure of liquid at that it is necessary to do rolling indents laid down 11,63 MPa. Attaching of indents of one of rotors was produced at the step increase of pressure of liquid, beginning from pressure of 8 MPa with the next increase of pressure on every degree on 0,7 MPa. Indents were attached at an $\omega = 8\ s^{-1}$ angulator and number of cycles of loading of N=10^2 on every degree. After every degree of rolling indents a hydromotor understood and conducted previous visual control of the state of active surfaces of indents, and also the size of maximal flowage was measured indents in relation to base points, profiles located out of active areas. At first(then rolling on the first stage) on the surfaces of indents it was observed for two active planes, located at tops and hollows of indents. Further rolling on next degrees resulted in the increase of width of active planes. At calculation pressure of liquid of p = of 11,63 MPa indents were fully attached. It costs to notice that as a result rolling indents the roughness of their surfaces got better approximately on two classes. The size of maximal flowage presented 80 - 100 mkm. The second rotor was subjected rolling rolling at calculation pressure of liquid of p = 11,63 MPa in the flow of N=of 10^3 cycles of loading. The state of active surfaces of indents and size of flowage of their surfaces were the same, as well as in first case. Then the rolling hooking executed on foregoing methodology, one of cylindrical indents changed the sensor of efforts the oscillographic record of the normal loading was executed on indents. On rice. 3 the theoretical over is brought and experimental the crooked sizes of the normal loading on indents depending on position of pole of hooking. An oscillogram of change of the normal loading is on indents(curve 2) depending on position of pole of hooking (sinewave 3), writtenin at pressure of liquid of p = 9,43 MPa. For comparison on a fig. 8 the theoretical dependence (curve 1) built on the basis of calculations on methodology driven to work is given also [8] at the of twisting moment of T=846 Nm, to the corresponding marked pressure of liquid.

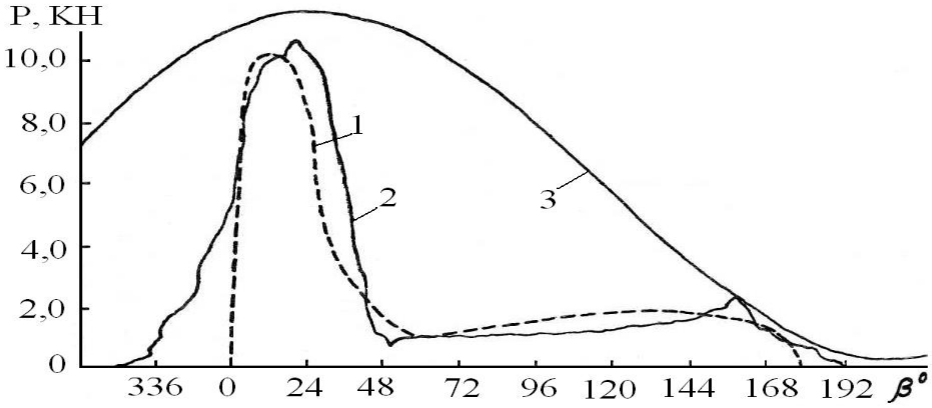

Fig. 3. An oscillogram of change of the normal loading is on indents(curve 2) depending on position of pole of hooking (sinewave 3).

From lines. 3 evidently, that law of change of the normal loading, experimentally, near-by the pole of hooking differs, from theoretical that near-by the pole of hooking indents go out $330^0 \le \beta \le 24^0$ a contact at the value of corner $\beta = 330^0$ and loading perceive approximately on one the indents more than it was accepted at calculations is a half of all indents. The increase of number of simultaneously contacting indents yet more positively influences on loading ability of hooking and compensates an insignificant decline it loading ability, by викликуване errors making of cylindrical indents, that at calculations was not taken into account. In connection with it, theoretical dependences for determination of pressure of liquid in a period rolling and exploitations of hooking are exact enough.

Conclusions. Experimentally confirmed possibility of increase of loading ability of hooking with the approximated profile of indents due to smoothing of pin напруг as a result of it rolling at a certain крутному moment that causes the insignificant(one order with resilient deformations of indents in a contact) flowage of active surfaces of indents. The executed researches showed that theoretical and experimental curves coincide with sufficient exactness.

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ЕКСПЕРИМЕНТАЛЬНОЕ ОПРЕДЕЛЕНИЕ НАГРУЗОК НА ЗУБЬЯ ВНЕЦЕНТРОИДНОГО ЦИКЛОИДАЛЬНОГО ЗАЦЕПЛЕНИИ ОРБИТАЛЬНОГО ГИДРОМОТОРА

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Ключевые слова: орбитальний гидромотор, внецентроидное циклоидальное зацепление, нагрузочная способность.

Резюме

Выполнен анализ существующих методик определения нормальных нагрузок во внецентроидном циклоидальном зацеплении. Дано описание разработаной методики и приведены результаты экспериментального исследования распределения нагрузок в зацеплении. Дано сравнение результатов экспериментальных и теоретических исследований.

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Summary

The made analysis of existent methodologies of determination of the normal loading is executed in the cycloidal gearing. Description of the worked out methodology is given and results over of experimental research of distribution of loading are brought in gearing. Comparing of results of experimental researches is executed to the calculation.