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ASPECTS CONCERNING DETERMINATION OF FUNCTIONAL PARAMETERES OF TRANSMISSION WHICH EQUIPED UNIVERSAL SEED DRILLS

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Abstract: *This paper presents some aspects concerning experimental determination of kinematic quantities values which characterize the functioning of gearbox with cam-balance-lever mechanism, view of representation and comparison of motion laws obtained by measurements with those outlined in the process simulation using the virtual prototype method. In order to determine the functional parameters of the transmission with intermittent motion was used an experimental installation, consists of the following modules: a hydrostatic drive system with continuously variable flow and a sowing department. Broadcast sowing transmission was designed to achieve two drive systems: by means of a mechanical transmission with intermittent motion which includes a gearbox with cam-balance-lever mechanisms, by means of a mechanical transmission with continuous rotation, which includes a Northon type gearbox. The technical system was composed of the following components: device for measuring by means of electrical impulses of speed, angular displacement transducer, card acquisition, signal amplifier and laptop. For perceive and measure the kinematics quantities were used a complex technical system of experimental investigation, which allowed the acquisition, processing and analysis of characteristic parameters and kinematics quantities.*

Key words**:** *seed drill, transmission, kinematics parameters*

INTRODUCTION

Transmissions with intermittent motion of universal drills have constituted gearbox consisting of a specified number of cam-rocker-type mechanism, mounted in parallel and operated out of phase. Rocker cam-type mechanisms transformes continuous motion, with constant angular velocity ω_1, the input shaft, the intermittent motion with variable angular velocity ω_2 output shaft. In the operation of the gearbox, with intermittent motion, summing impulses underlying principle of rotation, generated by all cam - rocker - overrunning coupling (Figure 1). [1]

During a full rotation of cam 2, rocker 3 is driven by its lobes, for each lobe of the cam, it is running with a oscillating movement with a β angle whose value is determined by the minimum and maximum radius of cam profile. The rockers 3 are mounted on a driven shaft 10 through a one-way clutch 5. Each lobe of the cam 2, leaves to the rocker *3* an intermittent rotating motion with a variable angle β, which dependents of the cominhback race of the rocker.

The comingback race of each rocker is a passive race, and is performed under the action of coil spring 6 mounted in prestressed condition. It is bounded by a limiting plate 7, which by its position controlling the angle of the roller gear cam. Position limiting plate (angle ψ) is adjusted by the lever 8, which can be mechanically locked in a fixed position, indicated by the graduated sector 9 (Figure 2) [3].

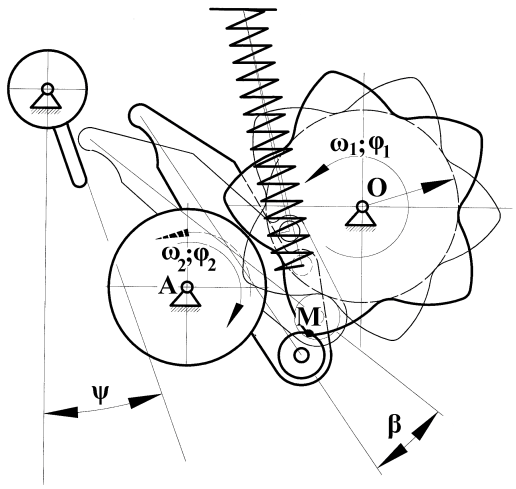

Figure 1.Cam-rocker mechanism.

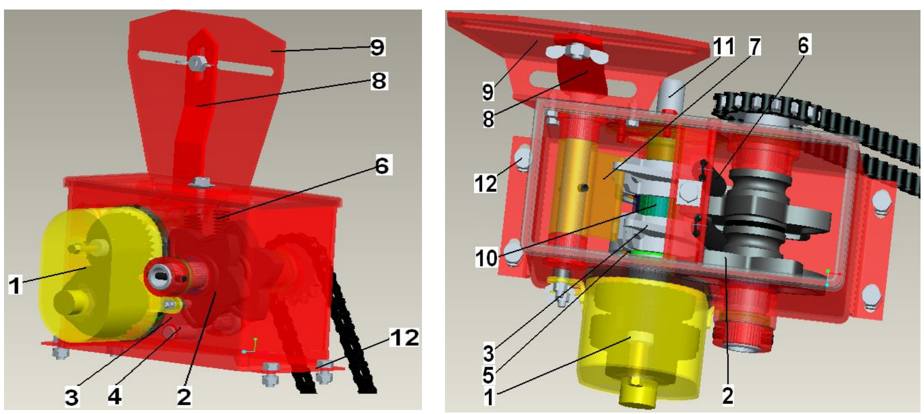

Figure 2: The construction of the cam-rocker mechanism gearbox [2]

MATERIAL AND METHOD

This paper presents an experimental research which had the following objectives: - to determine functional parameters with intermittent transmission and graphic representation of motion laws;

- the comparison of motion laws determined experimentally with those obtained by theoretical computer-aided simulation ;

- the determination of functional parameters with continuous transmission (gearbox Northon) and their comparing them with the transmission parameters with intermittent functioning.

In order to determine the functional parameters with intermittent transmission, as which equipes the universal drills, has been used an experimental installation consisting of the following modules: hydrostatic drive system with variable continuous flow (Figure 3, a), sowing department (Figure 3, b), the measuring system of the moment to gear metering devices, sensors for measuring kinematic variables of input and output shaft of the gearbox

To ensure the necessary working speeds dosing devices it was used a hydrostatic drive system with continuous variable flow which feeds a hydrostatic orbital engine (Danfoss type).

a.

b.

Figure 3: The equipment used for the experimental researche nstalația utilizată pentru cercetarea a. hydrostatic drive mode with continuous variable flow, b. Department of sowing equipped with transducers and devices used to measurement.

Hydrostatic drive system with continuous variable flow ensured hydrostatic orbital change engine speed limits 20 ... 160 rpm change that is achieved through flow divider.

To experimentally investigate the operating conditions of dosing devices, for the two drive modes: continuous rotary motion and rotating pulse, which implies that by rotating the dosing devices from an orbital hydrostatic engine *1* was designed to achieve two drive systems:

- through a mechanical transmission with intermittent motion which includes a gearbox with cam-type mechanisms rocker *4*;
- through a mechanical transmission with a continuous rotary motion, which includes a gearbox with gear type Northon 10, a chain transmission *8* and and mating gears 7 (Figure 4). This is possible by modifying the route of transmission of energy flow to dosage devices, which is possible by installing proper orbital engine hydrostatic engine *1*.

To determine the functional parameters were placed in the facility the following sensors and measuring devices: DMT speed measuring device; TDU angular displacement transducer, torque transducer to measure the TMA. Block diagram of the location of transducers and measurement devices is shown in Figure 5.

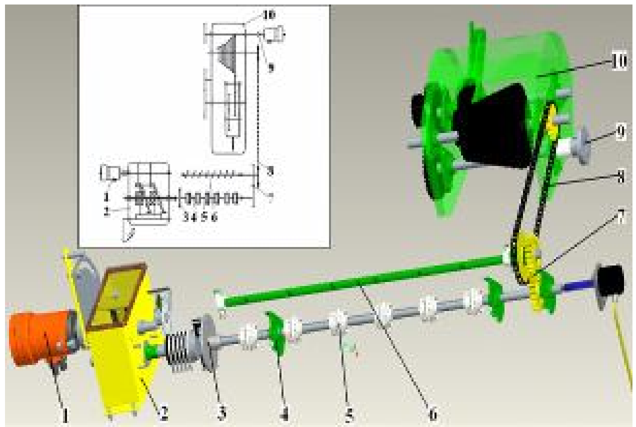

Figure 4: The scheme 3D system of teh transmission used to effectuate the experimental tries.

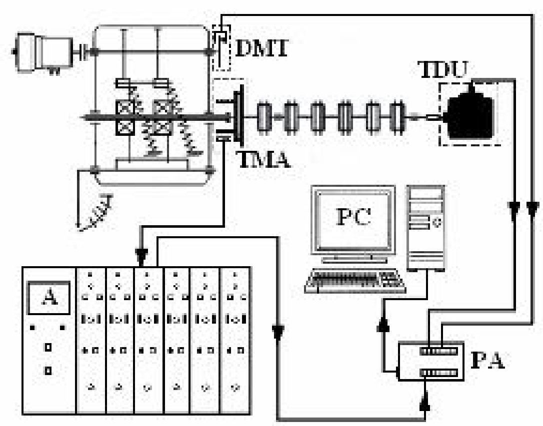

Figure 5: The block scheme of the equipment for the experimental researches
A – signal amplifier; PA – acquisition board; PC – computer;

RESULTS AND DISCUSSIONS

Within the experimental researches were determined by direct measurements, values of the following physical quantities: angular space made by the output shaft of the gearbox with intermittent operation, in degrees, input shaft speed gearbox with intermittent (hydraulic engine speed), in rpm, torque of the shaft of dosing devices, in Nm.

The data obtained, values were determined indirectly following physical quantities: speed shaft of dosing devices (ie output shaft of the gearbox), the rpm, gear ratio, pulse amplitude, in degrees; during the stationary shaft dosing apparatus between two pulses, in seconds.

Data from acquisition and processing operations are summarized in Table 1 - the gearbox with intermittent and Table 2 - for Northon gearbox. Based on these data were represented graphically motion laws underlying the operation of the gearbox with the cam-rocker-type mechanisms, for comparison with those obtained by theoretical simulation.

Table 1.

The functional parameters of the gear box with intermittent functioning

The handler position on the scaling sector	Experiemnt time [s]	Angular space of the outcoming shaft [deg]	The impulses amplitude [deg]	Stationary time [s]	The speed of the entrnce shaft [rot/min]	The speed of the outcoming sfaft [rot/min]	The transmisiion raport
0	10	999	17,88	0,03	35,20	16,39	2,11
10	10	936,3	16,58	0,045	35,20	15,19	2,25
20	10	838,3	15,24	0,055	35,10	13,97	2,51
30	10	822,1	13,70	0,06	35,67	13,7	2,60
40	10	697,4	12,31	0,07	35,45	11,62	3,04
50	10	610,3	10,17	0,08	35,28	10,07	3,46
60	10	496,4	8,65	0,09	35,20	8,27	4,25
70	10	444,2	6,73	0,10	35,10	6,16	5,69
80	10	370,2	4,52	0,11	35,15	4,15	8,46
90	10	248,9	2,40	0,13	35,03	2,20	15,92
100	10	132,2	0,96	0,16	35,04	0,88	39,82

Table 2.

The functional parameters values Northon gear box

The handler position	Experiemnt time [s]	Entrance spedd [rot/min/]	Angular space made by the shaft of metering devices [deg]	The speed shaft of metering devices [rot/min]	The transmisiion raport
C-1	10	35,15	231,123	3,85	9,125
C-2	10	35,2	243,01	4,05	8,691
C-3	10	35,12	255,232	4,25	8,256
C-4	10	35,05	268,857	4,48	7,822
C-5	10	35,1	285,095	4,75	7,387
C-6	10	35,1	302,890	5,04	6,953
C-7	10	35,1	323,105	5,38	6,518
C-8	10	35,2	347,197	5,78	6,083
C-9	10	35,05	372,278	6,20	5,649
C-10	10	35,05	399,506	6,65	5,264
C-11	10	35,15	420,622	7,01	5,014
C-12	10	35,07	441,780	7,36	4,763
C-13	10	35,04	465,957	7,76	4,512
C-14	10	35,05	493,430	8,22	4,262
C-15	10	35,08	524,756	8,74	4,011
C-16	10	35,05	559,308	9,32	3,76
C-17	10	35,16	601,196	10,01	3,509
C-18	10	35,2	648,051	10,80	3,259

To compare the motion laws obtained by measurements with those outlined in the process simulation is presented in Figure 6 diagrams of variation of angles of rotation of the output shaft of the gearbox (the law of motion, φ2 = f (t)) obtained experimentally and those obtained by simulation, for the following operating conditions of the gear box: input shaft speed, n1r = 35.2 rpm obtained from experimental measurements, ie *n1 = 35 rpm* used in the simulation; the rocker race card limit set in the corresponding race that maximum minimum lever is positioned on 0 and 100, during operation of the mechanism *t = 2 s*

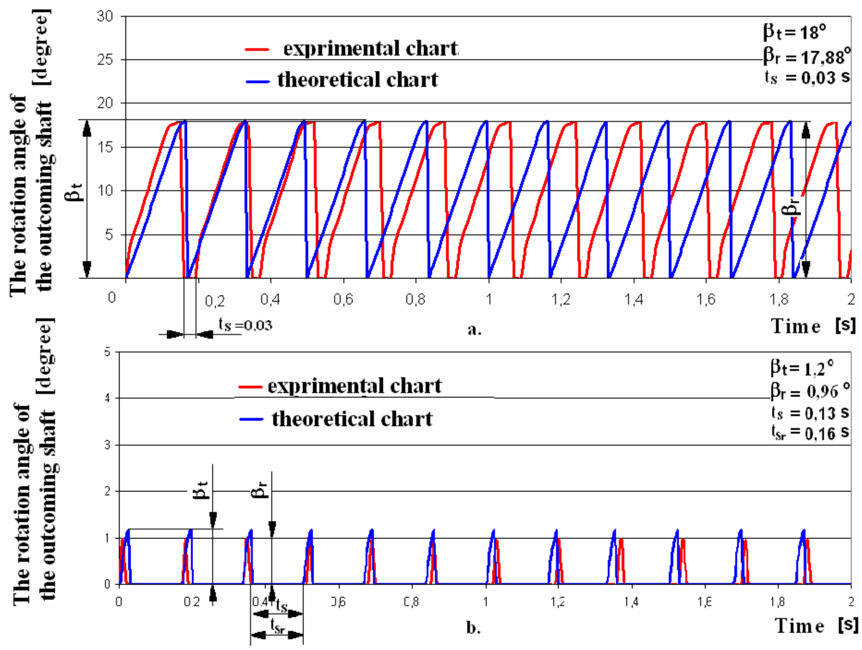

Figure 6: The variation charts of the roration angles of the outcoming shaft from the gear, for the maximum race (a) and for the minimum race (b)

From the diagrams shown in Figure 6 it is noted that the actual laws of motion output shaft of the gearbox are approximately identical to those obtained by simulation for both operating conditions studied. Differences between the two laws of motion, are due the following reasons:

- the experimental diagrams for each operating cycle, for maximum race to race and minimum parking time is $t_s = 0.03$ *s*, which is not included in the theoretical simulation. This time because the parking is actually not one-way couplings of flash blocks, as considered in the theoretical simulation;
- pulse movement amplitudes in experimental diagrams are lower than for those obtained by theoretical simulation. Thus the maximum stroke, pulse amplitude of rotation is 17,88 degrees for experimental research and theoretical simulation of 18 degrees. Minimum pulse amplitude race experimentally measured rotation is 0,96 degrees to 1,2 degrees for the theoretical simulation

When the rockers execute the maximum race the output shaft is determined only when the lock of one-way clutches, and when the comingback race of the rockers is limited, the stationary time is due to the fact that rocker rolls breaks the contact with the pins.

To highlight the unevenness of the movement when using a gearbox with intermittent use, in figure 7 are presented variation charts depending on time in angular space map of the drive shaft of the metering devices (diagrams obtained experimentally), in the case when it receives the rotation through the gearbox with intermittent function and that the movement where it receives the Northon gearbox, gearboxes in both cases making the same transmission ratio. Analysing the two diagrams it results the following aspects:

- for gear boxes with gear pinion, the space variation is uniform and continuous;

for the gear boxes vith cam rockers mechanisms, the variation of angular is made in in leaps, each operating cycle that there is one landing during the tree is immovable. Slope phase curve of the drive shaft is much higher, indicating a higher speed of rotation of the shaft during operation.

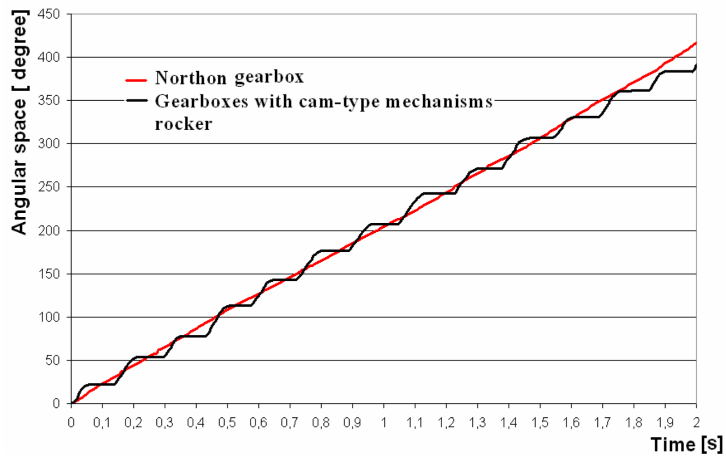

Figure7: The variation chart in time of the angular space made by the driving shaft of the metering devices, for the two types of gear bxes used to experiments

CONCLUSIONS

Gearboxes with cam-type mechanisms rocker introduce a degree of unevenness of movement shaft of dosing devices, this unevenness can only be reduced by using a cam with more lobes were the cam profile optimization when using cam-rocker mechanisms at the contact between cam and rocker is directly made.

The unevenness motion degree of the output shaft of the gearbox with servo-type cam-rocker, is a parameter characterizing the kinematics of these gearboxes. In experimental research by measuring the angles characteristic operating cycle of the cam-rocker mechanism, unevenness was revealed by determining the length of the shaft stationary phase in a cycle of operation of tee.

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