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CONTRIBUTION TO THE DYNAMIC STUDY OF THE MILL WITH HORIZONTAL AXIS. PART I: PRELIMINARY STUDY

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Abstract: *The work is part of a group of three works, in which the dynamics of a fodder grain mill, equipped with a horizontal shaft, which is directly welded on the shaft of the electric motor drive are studied. In the first part, the components of the dynamic system are established, for which the geometric dimensions are known, the connection relationships between the component elements, as well as the masses in the system and the mechanical system is prepared to obtain the mechanical scheme.*
Key words: *mill with horizontal axis, preliminary study of the mill dynamics*

1. GRAIN MILL OVERVIEW

The shredding of cereals and other grains has begun to practice since the Neolithic, with the emergence of the first stone mills, rapidly evolving in the modern period to the current complex milling facilities. The mill is aimed at shredding and transforming grain grains and some legumes in flour and crust. As a weight the wheat occupies the first place in the mill, the most famous species being the common wheat (Triticum vulgare), with the widest use in obtaining the bakery flour and the hard wheat (Triticum durum), used to obtain a special purpose flour, but especially in the flour used in the manufacture of pasta [6].

The technological characteristics of cereals have a huge influence on the processing process, the most important being: the size, shape and humidity of the grains, hardness, stickiness and their swagness, the hectoliter mass, the capacity of flow, float and self-sorting, conductivity and thermal diffusion, hygroscopicity thereof [1], [2]. Cleaning and conditioning seek to remove impurities and foreign bodies, as well as adjusting moisture to optimum grinding values.

2. HORIZONTAL SHAFT MILL FOR FODDER MIXTURE

Grain feed mixture grinding in general is done in mills with vertical shaft. These at first were manually operated, but with the mechanization of the mill food industry were built with electrical actuation. The transition from the vertical shaft mills to the horizontal shaft mills was made in order to obtain the feed mixture continuously flowing.

In this structured work in three parts, a detailed study of a grain mill mixed with a horizontal shaft is performed, to establish the vibrations that occur during the operation of the mill and how they act on the operator Human [3], which serves and supervises the mill with continuous operation [4]. The structure of this work was imagined as follows:

I. In the first of the work a preliminary study is made, establishing the:
   a. component elements of the mill;
   b. correlation between them;
   c. how the mill is trained;
   d. grated mixture granulation;
   e. and escape mode.

II. In the second part shall be established:

1. the reference systems to which the mill is reported;
2. reporting of constructive dimensions to reference systems;
3. mechanical characteristics of the rotating mill with horizontal shaft;

4. differential equation system.

III. In the third part is resolved:

- Matlab program that achieves the integration of the system of dynamic equations of the mill;
- the solution related to the law of movement of the mill and the dynamic reaction in the system;
- interpretation of the results.

3. MILL WITH HAMMERS

This type of mill is intended for grinding grain grains and is recommended to be used in livestock farms or other productive establishments.

Depending on the requirements of the beneficiary, the mill can be used in a fodder kitchen. By construction the mill ascites grain grains for grinding from a silo or supply bunker fitted with dosing systems and refuling the grinder into a feed mixer or silo of finished products, no other machinery is required for Supplying the mill or transporting the ground product [18], [19], [20].

3.1. Technical Characteristics

The grain mill intended for the fodder mixture operates continuously, therefore in the technical features will be mentioned both the supply and exhaust system. The enumeration of the technical characteristics is necessary for the systematization of the components of the mill.

Table 1.

Technical Characteristics

CRT No.	Name		U.M.	Value
1.	Size	Length	mm	680
		Width		650
		Height		780
2.	Productivity*		Kg/h	500-600
3.	Engine power		kw	7,5
4.	Engine speed		rpm	2900
5.	The discharge height		m	15
6.	Absorption distance		m	15
7.	Intake mouth diameter		mm	100
8.	The diameter of the discharge mouth		mm	100

* - Guaranteed productivity under the following conditions: the diameter of the sieve holes:

- 4 mm ;
- **g**rain humidity15 %
- the discharge height 15 m.

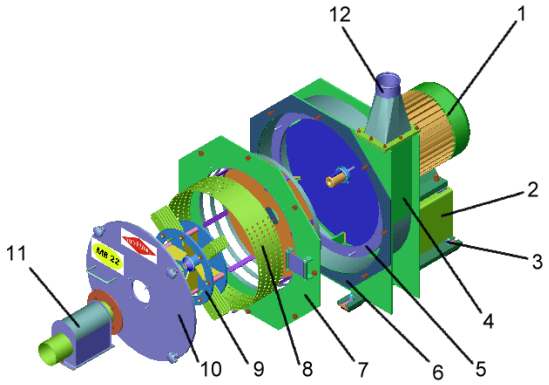

Fig. 1. Horizontal Shaft Mill [21]: 1 – Electric Motor; 2 – Engine Support; 3 – Adjustable Buffer; 4 – Mill Housing; 5 – Ventilator; 6 – Lining; 7 – Sieve Housing; 8 – Sieve; 9 – Rotor with Hammers; 10 – Cap Mill; 11 – Aspiration Mill; 12 – Discharge Mill.

3.2. Operation

The grain mill in a feed mixture called MB 7.5 is a high productivity mill, which works continuously, and is fed when part of the mill product is discharged through a cylindrical sieve, surrounding the mill in which the find the feed mixture [7], [8], [9]. Grinding is produced using four bundles of hammering, each groupage consists of four hamlets spaced between them, which can rotate freely around parallel axes with the axis of the mill [10], [11], [14], [15], [16].

Grinding is produced by tapping by the hammering of grain grains, which are continuously inserted into the mill cage. Grinding occurs if the ground granules are less than or equal to the cylindrical sieve mesh, which surrounds the mill cage and occupies all the spatial from inside the mill carcass [10].

3.3. Component

The grain mill in a feed mixture named MB 7.5 is analyzed from the point of view of the component, for this analysis [17] gives the necessary data to study the dynamics of the mill with horizontal shaft [21].

With the constructive and functional data, a centralizer table is drawn up. They are found in table 2, in which the current number and the name are preserved from Figure 1.

Table 2.

Mill's Component

Crt. No.	Name	Number of PCs.	Dimensions L / l / h or diameter x width [mm]	Mass [kg]	Component parts. Name/Observations
1.	Electric Motor	1	680 / 650 / 780	45	Aluminum casing
2.	Engine Support	1	132 / 216 / 140	12	Laminated steel sheet
3.	Adjustable Buffer	1	132 / 216 / 12	2	To attach the assembly
4.	Mill Housing	1	680 / 650 / 780	10,5	Component Parts Support
5.	Ventilator	1	400 x 5	2,4	Centered on the impeller shaft
6.	Lining	1	520 x 5	0,7	Ensure the sealing of the mill
7.	Sieve Housing	1	510 x 128	2.4	Fixated on the mill housing
8.	Sieve	1	510 x 128	3,2	Fixated on the sieve housing
9.	Rotor with Hammers	1	Ø300 x 189	38,252	The rotor with the Hammers is the component part of the mill, which produces the grinding [19]. It represents the dynamic element.
10.	Cap Mill	1	680 x 12	2,8	Shielded from dust and noise
11.	Aspiration Mill	1	100 / 500	0,5	Contains power mouth
12.	Discharge Mill	1	100 / 200	0,7	Contains the evacuation of grinds

Table 3.

Rotating Motion Parts

Crt. No.	Name	Dimensions[mm] L / l / h or diameter x width	No. PCs.	Unit Mass [kg]	Total mass[kg]	The distance of the center of the masses to the rotating axis [mm]
1.	Rotor ring	300 x 70	1	16,8	16,8	0.0
2.	Flange	300 x 70	1	16,8	16,8	0.0
3.	Hammer	128 / 40 / 6	16	0,2	3,2	110,0
4.	Distantier	25 x 5	20	0,01	0,2	110,0
5.	Bailey for hammers	16 x 49	4	0,073	0,292	110,0
6.	Bolt for hammers	10 x 57	4	0,023	0,092	110,0
7.	Clamp grip bolt	16 x 6	8	0,006	0,048	110,0
8.	Mouthpiece stopper	23,5 x 49	4	0,12	0,48	110,0
9.	Bolt Grip	23 x 57	4	0,067	0,268	110,0
10.	Clamping clamp bolt stopper	23 x 6	8	0,009	0,072	110,0

4. CONCLUSIONS

The work is part of a three-piece cycle, which studies the dynamics of the feed grain mill with horizontal shaft. In this preliminary part is determined the components of the mill, which will make the rotation movement, and which will produce the phenomenon of grind of grains necessary to feed the animals from the zootechnical farm of the Faculty of Veterinary Medicine in Cluj-Napoca.

The paper contains a study of the dynamics of the mill, which has not been approached in this manner. The study is necessary in the thesis, which refer the action of

vibrations on the human operator, which serves the mill with horizontal shaft.

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Contribuţii la studiul dinamic al unei mori cu ax orizontal. Partea I-a: Studiul preliminar

Rezumat *Lucrarea face parte dintr-un grupaj de trei lucrari, in care se studiaza dinamica unei mori de cereale furajere, prevazuta cu ax orizontal, care este direct sudat pe arborele motorului electric de antrenare. In prima parte se stabilesc partile componente ale sistemului dinamic, pentru care se cunosc dimensiunile geometrice, relatiile de legatura intre elementele conmponente, precum si masele din sistem si se pregateste sistemul mecanic in vederea obtinerii schemei mecanice.*

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