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CUTTING DEVICE

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When justifying the principle of operation and operating conditions of the crushing device, it is necessary to take into account the mutual influence of many structural, kinematic and loading parameters, taking into account the physical and mechanical properties of the processed material. The selection of the construction of the working bodies of the crushing device should take into account the linear dimensions of the rods, their configuration and strength under various types of deformations, which will allow, with justified kinematic and technological parameters of the machine, to grind the product with minimal energy consumption. Preliminary grinding of rods, carried out due to breaking on the part of two-stage toothed discs, must to increase the efficiency of the next grinding of the product by increasing the productivity of the machine that implements the second stage of the process, improving the conditions for particle capture by the feeding device and reducing the specific energy consumption. The proposed design of the crushing device allows you to obtain mixtures of a given granulometric composition, to achieve a reduction in the metal consumption of the structure and the energy consumption of the grinding process, and to quickly adjust the degree of grinding of the product.

Keywords: corn, fodder, mixture, cob, rod, flowability, knife, rotor.

STATEMENT OF THE PROBLEM, ANALYSIS OF RESEARCH AND PUBLICATIONS

Feeds using corn for the production of roughage for ruminants with crushed cobs that are processed to the state of bran have found considerable distribution. Further use of such fodder is advisable in combination with concentrated and juicy fodder. All components of corn have the necessary signs of good digestion by the animal body and are quite easily digested. The ear of corn is a thickened axis - a rod of cylindrical or cone-shaped shape and has a powerful well-developed complex conducting system that ensures the supply of developing grains with organic substances and water. Conductive tissues in the cob schematically represent two empty cylinders, inserted one inside the other. Researchers note two conducting systems in the stem of the cob: internal and external. The conductive system of the inner zone is represented by bundles located in the form of two concentric rings, and the outer one, located on the periphery of the rod, has some similarity with the inner one, although it differs in a number of features. The technological operation of grinding is the most energy-intensive in the work processes of preparing fodder in the form of hay, silage, grass flour and cuttings, combined fodder and complete ration fodder mixtures [1, 2]. There are well-known designs of crushers for grinding corn cobs [2, 3], in which the grain-cob mixture is fed by a screw conveyor into the crushing device, which is a stationary sieve with a diameter of 1050 mm with movable working bodies mounted on eight rotor beams, on each of which parallel scrapers with a sharp edge are attached to the outside of the forming sieve, and four pressing plates and four knives are attached to the inside. In total, eight fork pairs are formed, which move relative to the sieve at a speed of 60 m/s. The inner ones squeeze and grind the grain and pieces of rods, and the outer ones cut and push the mass out of the holes. Variable sieves with holes with a diameter of 12, 16 and 20 mm are provided to adjust the degree of grinding. The main disadvantage of the considered machine designs is the low degree of grinding and the high energy consumption of the grinding process.

PURPOSE OF THE RESEARCH: to substantiate the design of the crushing device, which will allow to obtain a mixture of the given granulometric composition, to achieve a reduction in the metal content of the structure and the energy consumption of the grinding process, operational regulation of the degree of grinding of the product.

MATERIALS AND RESEARCH METHODS

There are known technical solutions of crushing devices [4,5], which consist of a receiving hopper, a cylindrical working chamber, a rotor with knives, an unloading chamber of six counter-cuts and decks, a drive mechanism and an unloading conveyor. The machine is equipped with six packs of knives and counter-slices, in the lower part of the rotor there is a device for unloading the crushed product. The grinding chamber has windows around the perimeter to the anti-cutting, spring-loaded legs. The rotor is driven by an electric motor through a V-belt transmission. In the grinding mode, the rotor is equipped with four shortened knives in the first row, two or four knives in the second row, and two or four serrated knives in the third and fourth rows, and the grinding chamber is equipped with six packs of counterslices. With a machine productivity of 20 t/h and cob humidity of 45.5%, the specific energy consumption was 2.1 kW h, and the specific metal capacity of the structure M ud = 125 kg g/t. However, the degree of grinding was low, as particles larger than 4 mm reached 79.1%. However, for corn stalks with low moisture content, the use of such crushing devices is impractical due to the expected high energy consumption and insufficient efficiency of the process with a significant metal content of the structures, as well as the lack of a mechanism for operational regulation of the degree of crushing of the product. Therefore, such constructions were not used in agricultural production. As an object of research, the cores of corn cobs with the initial moisture content of W = 80.5%, subjected to threshing in a combine, were chosen. According to the task, search parametric indicators are shown in Table 1 The need to develop the design of the unit for preliminary grinding of rods is determined by the task of obtaining linear dimensions of crushed rods, which allow to ensure loading of the working area of the disc grinding machine with the screw feeding device, which ensures the final stage of the process [6].

Table 1. **Parametric indicators of the study**

Direction of research	Parameters		
	searching	permanent	variables
Chemical composition, nutritional value	-	Humidity 8± 0.5%	-
Granulometric composition	Length, diameter, density	-	-
Strength properties	Shear strength limit, compression	The size of the samples	Humidity 8...20%, variation step 2%
Determination of the rational values of the parameters of the disk shredder	Average length of crushed rods and energy consumption	Humidity 14± 0.5%	The gap between the disks is 5...25 mm, the angular speed is 10...50 s-1
Determination of the granulometric composition of crushed rods	Length, diameter, density	Humidity 8± 0.5%	-
Setting rational values of the parameters of the rod crushing process in the machine	Weighted average particle size, energy consumption, machine throughput	-	Humidity 8...20%, outlet clearance 0.2...8.0 mm, groove inclination 20...70o, speed 500...1000 rpm
Determination of the granulometric composition of crushed rods	Grain diameter, bulk density	-	-
Frictional properties of crushed rods and grits	Angles of natural slope and external friction	-	Humidity 8± 0.5%
	Coefficients of external and internal friction	-	The pressure on the product layer is 0.5...6.0 kPa star_border
Deformative properties of grain	Modulus of elasticity and lateral pressure	Duration 5 min.	Humidity 8±0.5%, hydrostatic pressure H= 2600...2900 mm Hg. Art.
Aeromechanical properties of grain	Rotation speed	-	Humidity 8...20%,
	Ratio ratio of fractions	Humidity 8± 0.5%	Air speed 0.5...6.5 m/s

RESEARCH RESULTS

The specified purpose is solved by the fact that, the crushing device, which contains gear-disc rotors, shafts, electric motor, transmission, movable bearing housings, fixed bearing housings, support post, fingers, leash rods, cross bars, traction threaded leashes, adjusting nuts, springs , rudder, lock-nut rudder, according to the design, contains gear-disc rotors, rotating towards each other, and composed of a set of larger and smaller diameter alternating disks, with a checkerboard arrangement.

Figure 1 shows a diagram of a crushing device consisting of gear-disk rotors 1 and 2, shaft 3, electric motor 4, transmission 5, movable bearing housings 6, fixed bearing housings 7, support rack 8; fingers 9, leash rods 10, transverse bar 11, traction threaded leash 12, adjusting nut 13, shaped bushing 14, spring 15, cup 16, washer 17, finger 18, leash threaded screw 19, steering wheel 20, counter nut steering wheel 21, bushings 22 , lock nuts 23.

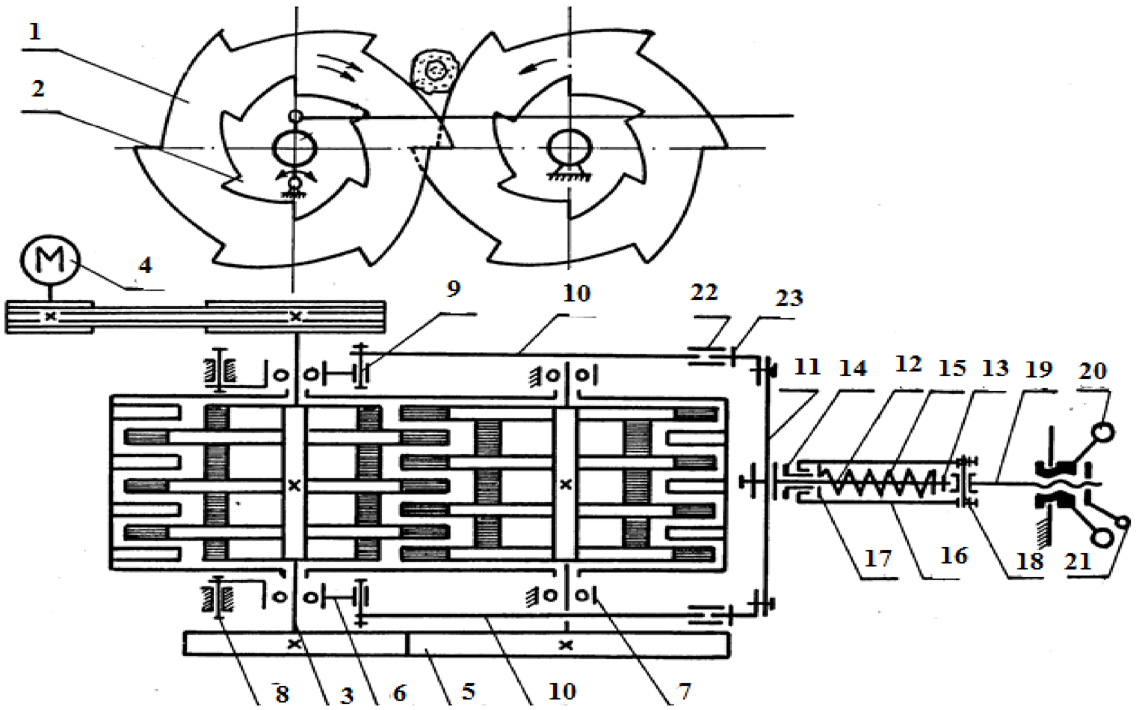

Fig. 1. Scheme of the crushing device.

The design included the following components: a bed, a grinding device, a mechanism for adjusting the working gap, and a drive-transmission device. The crushing device consists of two counter-rotating gear-disc rotors, each of which was composed of a set of alternating larger 1 and smaller 2 discs in diameter, fixed on parallel shafts 3. The staggered arrangement of the discs of the two rotors ensures the creation of a step-shaped capture zone , which allowed for horizontal orientation of corn stalks to carry out their simultaneous crushing into parts.

The counter-rotation drive of the rotors was made from an individual electric motor 4 through a V-belt and spur gear 5 with a gear ratio и = 2. The fast-rotating rotor is installed in the movable bearing housings 6, and the slow-rotating rotor is installed in the stationary ones 7. To adjust the size of the gap between the discs, the support racks 8 at their rotation relative to the stationary axes was simultaneously moved through the fingers 9 by two leash rods 10 connected to the transverse bar 11 by a common control mechanism.

The gap adjustment mechanism included a traction threaded leash 12, rigidly fixed to the transverse bar 11, a spring 15 was installed with an adjusting nut 13 and a shaped sleeve 14, the axial compression of which ensures an exaggeration of the interdisk force during the operation of the machine under constant load. The shaped sleeve 14 entered the cup 16 through a threaded connection and should move the washer 17 in the axial direction to adjust the tightening force of the spring 15 relative to the nut 13. To the end part of the cylindrical cup 16, a finger 18 with a lead screw 19, connected to steering wheel 20. The adjustment of the rod crushing mode was achieved within wide limits, the inter-disc gap when rotating the steering wheel 20 and moving the movable rotor.

To eliminate the self-rotation of the steering wheel 20 in the process of crushing the rods when the machine vibrates, a locking steering wheel 21 was used. In the event that a solid foreign object hits the working area of the machine, an increase in the inter-disc gap was provided, which was carried out due to the additional compression of the spring 15, the free movement of the threaded guide 12 in the sleeve 14 At the same time, the transverse bar 11 through the rods 10 ensures the rotation of both the housings of the movable bearings, which led to a uniform increase in the gap between the discs. After the passage of a foreign object, the spring 15 ensured the return of the system to the working position. To roughly adjust the size of the gap between the discs and the parallelism of their axes, the leash rods 10 were made split and had a right and left thread. By rotating the bushing 22, it was possible to ensure sufficient accuracy of setting the required initial inter-disc gap. Elimination of self-unscrewing of the sleeve 22 was achieved with a lock nut 23.

CONCLUSIONS

The crushing device includes gear-disc rotors, shafts, an electric motor, a support rack, leash pulls, transverse bars, traction threaded leashes, adjusting nuts, a steering wheel, a counter-nut steering wheel. Toothed-disc rotors rotate towards each other and are composed of a set of larger and smaller diameter alternating discs with a checkerboard arrangement. The staggered arrangement of the discs of the two rotors ensures the creation of a step-shaped capture zone, which allowed for simultaneous grinding of the corn stalks into parts when the corn stalks were oriented horizontally.

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ДРОБАРНИЙ ПРИСТРІЙ

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При обґрунтуванні принципу дії й умов роботи дробарного пристрію необхідно враховувати взаємний вплив багатьох конструктивних, кінематичних і навантажувальних параметрів з урахуванням фізико-механічних властивостей оброблюваного матеріалу. Вибір конструкції робочих органів дробаргого пристрію повинен бути з урахуванням лінійних розмірів стрижнів, їх конфігурації й міцності при різних видах деформацій, що дозволить при обґрунтованих кінематичних і технологічних параметрах машини подрібнювати продукт із мінімальними енерговитратами. Попереднє подрібнення стрижнів, здійснюване за рахунок розламування з боку двоступінчастих зубчастих дисків, повинне підвищити ефективність наступного здрібнювання продукту за рахунок збільшення продуктивності машини, що реалізує другий етап процесу, поліпшення умов захоплення часток живильним пристроєм і зниження питомої витрати енергії. Запропонована конструкція дробарного пристрію дозволяє отримувати суміші заданого гранулометрического складу, досягти зниження металлоємносі конструкції та енергоємністі процесу подрібнення, оперативного регулювання ступеню здрібнювання продукту.

Ключові слова: кукурудза, корм, суміш, качан, стрижень, сипкість, ніж, ротор.