Computer aided design and research on energy saving self-propelled ginger receiver

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Abstract. The existing ginger harvester is mainly a step-by-step harvesting operation, which can only complete the excavation process, and operations such as ginger harvesting and cuttings must be completed manually. The low recovery rate of ginger mother will not only cause the loss of the economic value of ginger, but more importantly, it will cause or aggravate the outbreak of ginger plague and pests, which will affect the production of ginger and the ginger next year. Combining high-quality and efficient self-propelled ginger with mining, ginger recycling, sapling cutting, boxing and other functions will promote the healthy development of the urban ginger industry and increase farmers’ income, which is very realistic.

Keywords: Self-propelled ginger harvester; ginger mother acceptance; solution.

1. Introduction
Ginger cultivation abroad is mainly carried out in Australia, Japan and South Korea. Australia belongs to highland agriculture. The ginger harvesting equipment is highly efficient and can cut, excavate, transport and load ginger seedlings at one time. But the method is rough and does not pay attention to the survival of ginger mother. Regardless of the adaptability of planting methods or the quality of harvesting, the recycling and completeness of ginger are far from reaching the requirements for ginger harvesting in my country. [1-5] The national production ginger harvester is mainly divided into two types: excavation type and lifting type according to the operation mode. For example, the 4JW-1 four-wheel drive self-propelled ginger harvester was originally developed by the Longkou Agricultural Machinery Expansion Station in Shandong Province. The whole machine is operated by manual hydraulic pressure. Four-wheel drive mode, crop cultivation and weeding, has the characteristics of sufficient force, strong adaptability, good operability, high work efficiency, and low loss.

Looking at the development characteristics and external environment of multifunctional ginger harvesters at home and abroad, experts predict that the main development trends of multifunctional ginger harvesters in the future are as follows: safety and versatility are important goals of product development; development of energy saving, high efficiency, reliability, and environmental protection Multifunctional ginger harvesting machine.

2. The working principle of sprocket
The self-propelled ginger harvester designed in this paper is mainly composed of a V-belt, a reducer, a rocking wheel, a frame, an excavator, a transmission chain, and a ground wheel. The tractor generates
electricity, and the required power is transmitted to the sprocket through the reducer and pulley, which drives the chain to move the separator, and the ginger excavated from the excavator is transported to the rear of the machine. At the same time, the effect of ginger through the wheel vibration is to realize the separation of ginger and soil during transportation, and achieve the purpose of separation. Finally, Jiang fell into the collection box. As shown in Figure 1. (1: Excavation loosening mechanism; 2: Ginger mother recycling mechanism; 3: Bottom cleaning mechanism; 4: Continuously variable speed track chassis; 5: Full hydraulic system; 6: Ginger seedling cutting mechanism; 7: Ginger seedling conveying mechanism; 8: clamping and conveying mechanism; 9: conveying and placing platform; 10: manual platform)
This design is intended to solve the problem of soil compaction and drought caused difficult excavation. The resistance of ginger harvesting and excavation is high, the entrainment is inclined, and the shape of the front is low and the back is high, so that the harvester slowly pulls up to ensure the complete shape of the ginger. Reduce the recovery damage rate and improve the recovery rate of ginger mother.

The sprocket material must be able to meet the strength and wear resistance requirements. For low speed, light load, and smooth transmission, the sprocket can be made of medium carbon steel with a hardness between 40HRC and 45HRC. The surface is carburized and quenched, which can realize fast and firm continuous operation. This multi-functional ginger harvester is made of medium carbon steel and low carbon alloy steel. Due to the medium speed and medium load, the medium carbon steel quenching process is adopted, and the hardness is between 40HRC and 45HRC.

3. Design of coupling

Main Specifications:
- Type: self-propelled;
- Supporting power: ≤30kW;
- Number of job lines: 1 line;
- Adapt to line spacing: ≥70cm;
- Operating speed: ≥0.5-1.5km/h;
- Excavation depth: ≥10cm;
- Loss rate: ≤3%;
- Ginger injury rate: ≤5%;
- Impurity rate: ≤5%.

The function of the upper shaft of the coupling is to connect the reducer and the pulley through the coupling. The design process is as follows:

(A). the shaft 4 part is equipped with a coupling. The length of the coupling is 112 mm. Therefore, the length of this part can be designed to be 110 mm;

(B). For shaft 3, the distance from the inner wall of the frame to the center line of the frame is 346 mm, so the distance from the center line of the reducer to the end of the output shaft is 214 mm, and the coupling length is 112 mm. The width is 24.75 mm. Therefore, the length of the shaft is designed to be 42 mm;

(C). Shaft 2 part: This part is also equipped with a bearing end cover. The length of this section can be designed to be 44 mm, so that the output frame of the V-belt wheel is 20 mm.

The designed width of the ginger harvester is 712 mm, and the wall thickness of the frame on both sides is 10 mm. Therefore, the internal space of the entire frame is 692 mm, and the outer extension of the selected reducer output shaft is 110 mm. To run the machine, the V-belt pulley must be placed outside the entire frame. The extension shaft of the reducer is not long enough, and a coupling must be selected. If you look at the reducer parameter table, you can see that the diameter of the output shaft is 48 mm, so the opening when selecting the coupling should be 48 mm. HL4 type coupling can be selected, the length is 112 mm.

4. Design of separation conveyor

The rod-type separating conveyor is a separator in which rods are arranged in parallel at equal intervals and connected by flexible elements. But this kind of separation conveyor is different according to the type of working surface. The working surface is a continuously moving grid composed of a large number of rods. According to the type of working surface, the degree of crushing and sieving of the moving soil are different. It will be decided.

At the same time, it affects the durability of the separation conveyor. For harvesters of ginger, tubers and other crops, the common separation conveyors are hook rod type, chain rod type and belt rod type. The hook rod type and the chain rod type have relatively simple manufacturing processes and low cost. The contact area between the chain rod and the soil is small, the screening strength is the largest, and
the separation effect is obvious. The chain-rod separating conveyor is composed of round bars, and the two ends of the round bars are welded to the chain. The ginger is sieved and formed into a grid to separate the soil. The chain-rod-type separating conveyor is driven by sprockets fixed on the driving shaft and the driven shaft, and each rod forms an endless chain belt.

The chain-rod separation conveyor is a separator and a conveyor. When the excavated soil or ginger is moved upwards under the action of the conveyor chain, the soil loosens and passes between the rods. Screen out the gaps, use a conveyor belt to transport the ginger to the rear, and collect the ginger in the rear collection box to achieve the purpose of harvesting ginger.

During operation, the front excavator enters the soil layer and digs out the whole piece of ginger. The function of the excavator is to crush the excavated soil block and transport it to the separation conveyor. When the separation conveying rod moves backward, it vibrates up and down under the action of the vibrator to loosen most of the soil and fall to the ground. The ginger is transported by the conveyor belt to the collection box at the end of the machine.

When selecting a linear speed for a conveyor, the life, size and weight of the conveyor are all related to the speed. When the separation conveyor is running, its linear speed must be slightly higher than the machine's forward speed to ensure the normal movement of the excavated objects. The running speed of the machine is 1.2 m/s, and the speed of the separating conveyor is 1.3 m/s, so the calculated value is 1.08. The determination of this parameter meets the requirements because it is in the range of 0.8 to 2.5.

The linear speed and the jitter performance of the jitter separation conveyor of the multifunctional ginger harvester are the main factors that affect the separation rate and breakage rate of ginger. Through the analysis of the kinematics and dynamics of the separating conveyor and the vibrating screen, the kinematic relationship between the separating conveyor and the vibrating screen is explained, the vibration and throwing performance of the vibrating screen are analyzed, and the theory of determining the linear velocity of the vibrating screen is applied.

5. Design of ground wheel and frame
The main function of the ground wheel is to balance and support the machine while walking. In order to overcome the greater resistance at the front of the excavator when the harvester is harvesting, the designed ground wheel needs to have better passability and can accurately control the digging depth under uneven ground conditions. The material of the grindstone is cast iron, and the structure is web type. There are various installation positions on the frame, and the depth can be adjusted according to the planting situation.

The suspension device of the multifunctional ginger harvester affects the main working performance of the harvesting unit, such as soil permeability, digging depth stability performance, unit traction performance, transportation performance and adaptability to the ground. The design adopts the three-point suspension mechanism composed of the three-point suspension at the rear of the tractor and the harvester suspension frame, which can be considered as four four-bar linkage mechanisms on the vertical and horizontal planes. These two 4-bar linkage mechanisms have their own instantaneous center of rotation. During the drilling process, it rotates around the two moment centers under the action of various forces, and keeps balance under the action of the relative moment of the moment centers. Most of the suspension and frame parts use rectangular tubes, which reduces the quality and cost, and also meets the rigidity and strength requirements of the structure.

6. Conclusion
Based on the research of self-propelled combine harvesters, this paper studies the problems of soil compaction and drought caused difficulty in excavation. By matching the moving speed, the position of the clamp is kept almost level with the ground, so as to ensure the completion of the ginger block and reduce the harvest. Damage rate, improve the recovery rate of ginger mother.

High-quality cutting of ginger seedlings is achieved through the research of ginger block shape characteristics, ginger storage requirements, ginger seedling cutting knife, hydraulic drive and other technologies. Innovative research and development of harvesting technology solutions such as
combined reduction mining of ginger, ginger mother body recycling and soil ginger separation and transportation, low-loss ginger transportation, ginger cut seedling transportation, ginger block stacking and other harvesting technology solutions, realized the ginger compound harvesting operation and the compound ginger Of harvesting operations.

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