RESEARCH AND MANUFACTURE OF A ROTATIONAL COIN SORTING MACHINE

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To solve the problem of huge cost of human and material resources when sorting coins in banks, shopping malls and bus companies. A coin sorting device is first proposed and designed based on structural optimization design. The novel device can automatically sort coins and save a lot of labor. The structure of the machine is designed ingeniously, and the function of layer-by-layer coin sorting is realized through the cooperation among slopes of between different sieve plates. The machine has the advantages of low cost, stable operation and reliable performance, which effectively realizes coin sorting. In addition, the design and machine provide a novel research direction on coin classification and sorting.

Keywords: coin sorting; rotational sorting; structure optimization; green design

1. Introduction

Coins are an important part of a country's financial system and are almost ubiquitous in daily transactions and applications. The specifications of the coins are uniform and easy to be identified. In addition, coins are not easily worn out and can be calculated for a long time [1]. Many scholars in the world have done a lot of research on coin sorting. Wang [2] developed a novel coin sorting and counting machine to solve the problem of coins counting. This new proposed packaging machine improves the efficiency of coin counting and reduces labor intensity. Martin [3] develop a unique high-speed coin sorting machine based on optical recognition, and different coins from about 100 countries can be classified and sorted with a speed of up to 10 coins per second. Lu [4] present an effective approach based on eddy-current sensors enabling rapid identification of different coin classes in this work. Jiang [5] proposed a portable coin sorting and counting device to solve the problems of manual operating, such as time consuming, energy consumption and low efficiency. Liu [6] designs a machine that can achieve can

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partially or completely replace labor to reduce labor costs, and the design has simple structure and low cost. Feng [7] designed an automatic classification device which can categorize the fifth edition coins and realize the functions such as sorting, separation and counting. The main function of mechanical device is to classify, count and sort all the mixed and sorts of notes and coins. Panasyuk [8] investigated sensor for measuring the length of a through crack propagating in a metal plate. Jiang [9] study a coin testing technology for an Automatic Coin-Wrapping Machine. Lei [10] proposed a coin sorting machine consists of feeding, separation, collection, arrangement. It can achieve to separate and arrange a Yuan RMB, 0.5 Yuan RMB, 0.1Yuan RMB of threekinds of coins.

However, with the development of the Internet and scientific progress, coins will increasingly reveal some problems. For example, coins are used generally in bank, bus transportation, automatic machine and shopping mall etc., but it is a huge problem to sort multifarious coins [11]. At present, there are already vibrational and centrifugal coins sorting machine shown in Figs. 1 and 2. However, the classification of vibrational and centrifugal coins sorting machine is inaccurate and cannot solve the problems of stocking and disassembly. Thereby, they have not been used widely, and the sorting is still done manually by humans at present. There is no doubt that this way is laborious. Therefore, this paper design and investigate a rotational coins sorting machine shown in fig. 3.

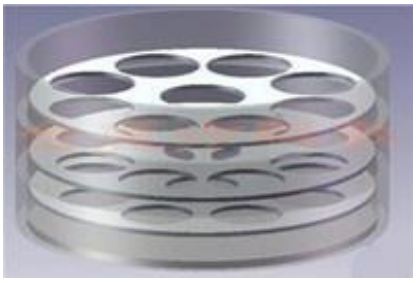

Fig. 1 Vibrational coins sorting machine

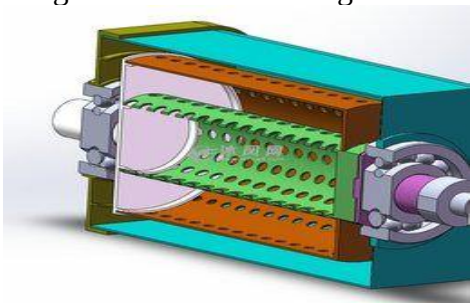

Fig. 2 Centrifugal coins sorting machine

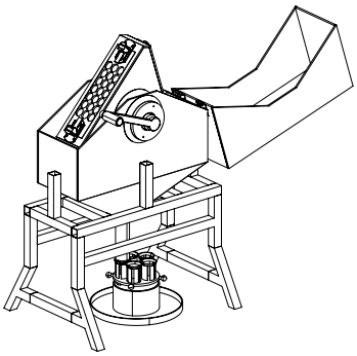

Fig. 3 Rotational coins sorting machine

2. Introduction of installation

The exploded structure diagram of coins sorting machine is shown in Fig.4. The coins sorting machine are mainly made up of coins storing box①, rocker driving device②, coins sorting box③, helical deliver device ④, the device of coins counting and packaging⑤, bracket⑥.

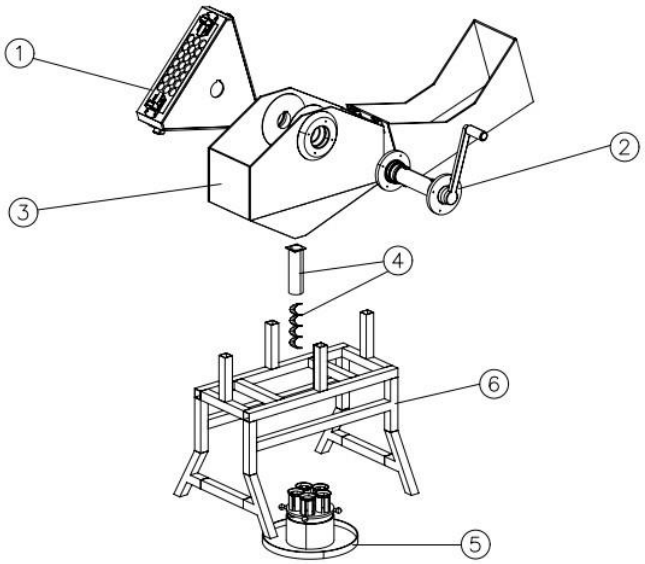

Fig. 4 Exploded structure diagram of coins sorting machine

A. Coins Storing Box

As shown in Fig. 5, coins store box is mainly composed of triangle box and three sieve plates. Because there are three different diameter coins, three in each group. Therefore, the box has nine sieve plates. The sieve plate is connected to the triangular box by a hasp.

①The sieve plate

According to the different diameters of coin's sizes, the sieve plate could make corresponding hole sizes. Apparently, the coins will be sorted out with different sizes.

②The frame of sieve plate

The inner ring size of frame is equal to the outer size of the sieve plate, and there are four metal plates at the bottom of the frame so that sieve plate can be installed on the frame.

③Hasp

Hasp is used to fix the frame.

④Connection plate

The connecting plate is a transitional structure between two triangular side plates, which has the effect of sharpening the edges of the box. And it is not easy for coins to be stored at the junction of the two sieve plates.

⑤Triangle side plate

There is a hole in the center of the triangular side plate, which corresponds to the diameter of the shaft, and the shaft is linked by a key.

⑥Thickened truncated cone

There are thickened truncated cone on both sides of the triangular box, which increases the thickness of the entire side plate and makes the key connection closer.

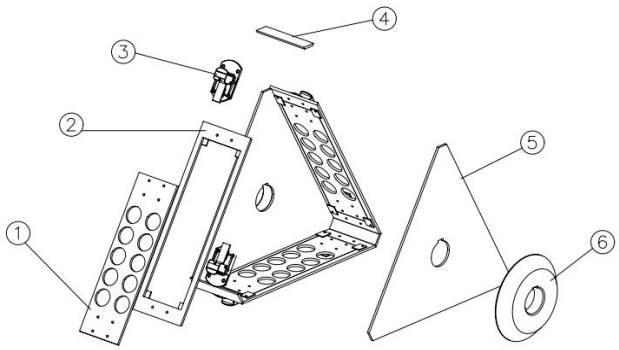

Fig. 5 Coins storing box

B. Rocker Driving Device

The rocker driving device is composed of a rocking handle and a transmission shaft shown in Fig. 6. The shaft is connected to the triangular storage box with a flat key, and the shaft is connected to the box with a deep groove ball bearing. In addition, the end of shaft has a hexagonal hole for connecting the rocking handle.

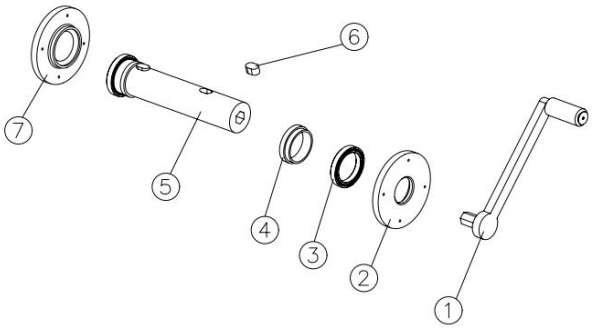

Fig. 6 Rocker driving device

①Rocking handle

The rocking handle is the main drive component, it uses hexagonal steel and fits closely with the shaft. The end of the rocking handle has a movable rotating handle, which makes rocking handle more comfortable and convenient.

②Opening cover

The opening cover is used to fix the axial displacement of the bearing and also prevent the lubricant from splashing. There is an important role in protecting internal components.

③Bearing

The bearing adopts the ring-shaped deep groove ball bearing with the model number 62807, which makes the relative motion of the shaft and the box more stable and reduces the noise.

④Shaft sleeve

The shaft sleeve is used to fix the relative position of the shaft, and also has the function of a shaft shoulder to facilitate disassembly.

⑤Shaft

As the main rotating part of the device, the shaft has the function of transmitting torque. The keyway of the shaft is used to connect the shaft and the triangle box, and there is a groove on the shaft for the circumferential fixation of the shaft and the rocking handle.

⑥Key

It is the part connected to the shaft and triangle box.

⑦Ending cover

The ending cover fixes the axial displacement of the bearing and prevents the lubricant from splashing, which plays an important role in protecting the internal components.

C. Coins Sorting Box

The coins sorting box is composed of the box cover and the box itself shown in Fig. 7, and the lower part is inclined so that the fallen coins can pass through the circular hole under the sorting box.

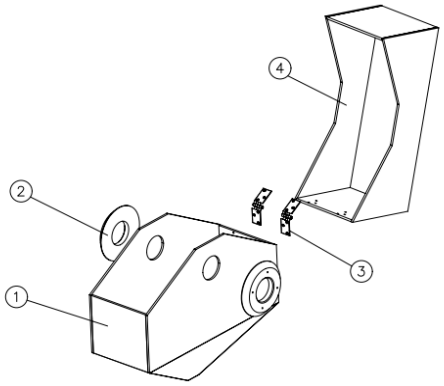

Fig. 7 Coins sorting box

①Box

The coins are filtered by the sieve plate and fall into the bottom of the box. The bottom of the box is inclined so that the internal coins slide into the sleeve below.

②Thickened truncated cone

The truncated cone is welded to the side plate of the box, which thickens the width of the entire side plate, making it more closely matched with the bearing.

③Hinge

The hinge is used to connect the box cover and the box body.

④Box cover

The main function of the box cover is to prevent the triangle box from rotating too fast and preventing coins from being thrown out of the box. The box cover plays a protective role.

D. Helical Deliver Device

The main purpose of the helical deliver device is to make the coins fall down one by one in order and without stocking, as shown in Fig. 8

① Sleeve

The upper part of the sleeve is connected with the bottom of the box by a square flange, and the sleeve prevents the coin from being thrown out during the process of falling along the spiral ladder.

② **Spiral ladder**

The function of the spiral ladder is to make the coins fall one by one and slowly.

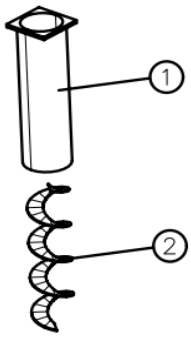

Fig. 8 Helical deliver device

E. The device of coins counting and packaging

The device is mainly composed of a turntable and a base shown in Fig. 9. The base is equipped with a stepping motor and a gravity sensor. There are five small cylinders on the turntable, and each small cylinder has three slender openings on the side. A scale is marked on the outside of each small cylinder, and the counting of coins can be completed by reading the scale. There are four threaded holes on the turntable for the connection of small handles. At the same time, the upper part of each small cylinder is made into a funnel shape, so that the fallen coins can fall into the small cylinder and will not fall outside during the operation. Whenever a turntable is full of coins, remove the turntable and replace it with an empty turntable to continue collecting.

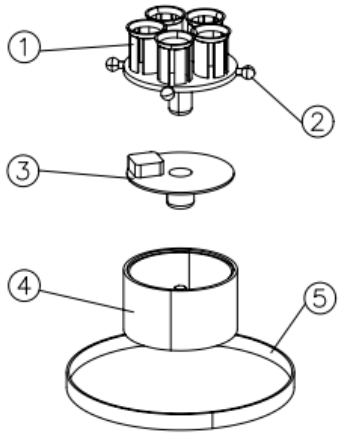

Fig. 9 Coins Counter and Packaging Device

① Turntable

There are five small cylinders on the turntable, and each cylinder has a slender small opening on its side. The outer scale of each small cylinder is used to read the number of coins. There are four threaded holes on the side of the turntable for connecting the turntable and the handle.

② Handle

The handle provides another driving method. When there is a problem with the gravity sensor or the stepper motor, the turntable can be rotated manually.

③ Gravity sensors

When a small cylinder receives full coins to reach a certain weight, the signal will be transmitted to the stepping motor, and then the motor will rotate a certain angle to continue collecting coins in another small cylinder.

④ Base

There is a stepping motor inside the base, which also supports the rotation of the turntable.

⑤ The plate of coins collecting

After the turntable is full of coins, pull out the turntable and replace the turntable. The function of the plate of coin collecting is to collect the fallen coins when changing the turntable.

F. Bracket

The bracket is welded by a stainless-steel square tube shown in Fig. 10. Four vertical steel tubes limit the displacement of the box in the *x* and y directions, and the box can be firmly fixed on the bracket. At the same time, the lower four legs of the box are made inclined, which makes the box more stable and not easy to tip over.

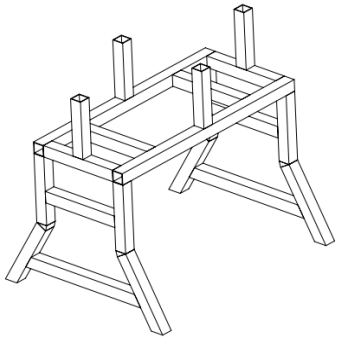

Fig. 10 Bracket

3. Benefits

A. Not easy to get stuck

The general vibrating coin sorting machine is more tend to get stuck. And the coins will not easily fall after being stuck. In contrast, this design has the ability to automatically solve the stocking problem. The motion of the coin box is circular. The direction of gravity and friction on the coin is not fixed, and there

will always be other coins impacting it. Therefore, even if individual coins get stuck, they will eventually fall into the small cylinder.

B. The speed can be controlled

Compared with motor driving, the biggest advantage of rocker driving is that the speed can be controlled. The speed of coin sorting can be adjusted according to needs, and the function of forward and reverse rotation can also be realized.

C. The efficiency of coins sorting is efficiently

Due to the large volume of the box, many coins can be sorted at one time. And the sieve plate is almost full of small holes, so you can filter many coins at a time. And the filter plate is almost full of small holes, so many coins can be screened at a time. At the same time, the height of the small cylinder is enough to hold 20-30 coins, which reduces the frequency of switching small cylinders and saves labor resources.

D. The classification of coins is accurately

The holes of filter plate are design strictly according to the diameter of coin, so there would not be big coins ran to the small coins pile.

E. Noise is small

Because the coin sorting is driven by the rocker, an electric motor and a gearbox can be omitted. As we all know, the motor and gearbox are the main sources of machine noise. The sorting of coins is driven by the rocker can reduce unnecessary noise and waste of resources.

F. The banknotes can also be sorted

After the coins are sorted, all the money left in the coin box is banknotes. Because the banknotes are basically unfolded, and they will not clump into a shape smaller than the diameter of the coin. Therefore, the banknotes can also be sorted.

4. Experiment and Conclusions

The physical image of the machine is shown in Figure 9. The design mainly uses sieve plates to sort and identify coins of different diameters. The spiral structure solves the problems of stocking and inaccurately classification. Coins can be packed and counted efficiently. The rocker driving conforms to the green design and the best design, which is more friendly to the environment.

This design theory has a practical significance, and we will use the knowledge of this book to practice and improve our ability to solve problems.

Coins will replace paper in the future, so the sorting of coins is very important. We can apply the principle to garbage classification and save space. The machine has good economic and social benefits and can be used in many fields at the same time. In addition, we have already applied and passed the Chinese national patent application.

Fig. 11 Physical image of the coins sorting machine

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