Improved Design of Lifting Slide Rail System of Stone Processing Machine

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Abstract. In this research, improved design for the lifting slide rail system on stone processing machine has innovated in a few aspects, including the innovative design of the lifting rail, fixture to fix and connect with the hydraulic tappet, and the sliding block equipped with limit device etc. The improved design has been successfully applied to the stone processing machine to crush and process block and stone flake processing waste of different shapes, it turned out that the needle flake particle content and crushing index of the processed stone are in line with the national standard requirements, i.e. crushing index of 7.2%, reaching the technical requirements of Class I crushed stone. In another words, the improved design has significantly improved the processing efficiency and safety and reduced costs effectively; meanwhile, its handy operation and utilization has made it ready to promote in a wider range.

1. Introduction

At the time being, stone processing has become an important cornerstone industry in Fujian Province, which has greatly driven industrial development and economic growth[1]. At one and the same time, the stone processing however, yields a large amount of waste such as trimmings. Provided that they are remained untreated, huge waste of resources and serious environmental pollution will be incurred[1-2]. Studies have suggested that in recent years, the stone industry have been inflicting more and more issues or phenomena, such as the so-called “Milk creek”, “Pneumoconiosis” and “Stone desertification” etc.[3-7] Amidst this backdrop, developing and utilizing stones efficiently and resourcefully, and constantly alleviating the contradiction between resource development and environmental protection etc. Have become critical means to address the waste of stone resources and environmental pollution of stone processing waste[2-4].

In light of the above reasons, this research have designed a method of using stone processing waste to prepare artificial sand for mortar and concrete, which is conducive to achieving environmental protection, enhancing economic efficiency and promoting the process of sustainable development of stone resource utilization[8]. As it known to all, stone processing plants entail a large amount of block and flake waste of various shapes in the process of processing raw materials and trimming products. Wastes of this kind can happen to meet the requirements of raw material for construction sand, crushed stone and admixtures, and by appropriate processes, they can be processed into such alternative products or raw materials as crushed stone, artificial sand, stone chips, and stone dust. To sum up, this study has improved the design of the lifting slide rail system of stone processing machine,
and successfully applied it in the preparation of crushed stone raw materials. Such endeavors have significantly enhanced the processing efficiency and safety, and reduced the cost effectively.

2. The Lifting Slide Rail System of Stone Processing Machine

2.1. Existing Lifting Slide Rail System of Stone Processing Machine

Thorough the research, it is found that the existing slide rail system of stone processing machine is mainly adopting the patent technology with application number CN201621346973.1, whose structure includes lifting trail, buffer, guide rail, trigger device, alarm. Wherein the lifting trail is fixedly connected to the buffer, while the buffer is fixedly mounted on the guide rail, and the guide rail is fixedly equipped with trigger device, alarm. Moreover, trigger device is connected with the alarm. As to the buffer, it consists of a spring, an outer rod, an inner rod, a buffer shim; among which, the spring is fixedly connected to the bottom end of the outer rod, whereas the outer rod is fixedly connected to the inner rod, and the inner rod is fixedly connected to the buffer shim, besides, the buffer shim is fixedly installed in the guide rail. The stone processing process have proved that in such design, the cushioning effect is poor; meanwhile, in the case when the contact pressure between the cutting tool and stone is large, the system can merely be able to sound the alarm and no more, resulting poor practicality and effect, and further low stone processing efficiency and considerable cost.

In this regard, this research has designed another lifting slide rail system for stone processing machine. The new design has addressed the issue of poor cushioning, and what’s more, excessive pressure between the cutting tool and stone can automatically trigger the alarm, which significantly improves the efficiency of stone processing and decreases costs notably. As of today the technology has awarded the national authorized utility model patent.

2.2. The Improved Design of Lifting Slide Rail System of Stone Process Machine

Figure 1 represents the improved structure design of the lifting slide rail system for stone processing machine. While Figure 2 marks the top sectional view of the limit device, and Figure 3 stands for an enlarged view of the structure at point A in Figure 1. In this figure, each number stands for the following parts: 1 lift trail, 2 fixing base, 3 fixed block, 4 hydraulic tappet, 5 the first spring, 6 slider, 7 limit device, 71 mobile block, 72 limit base, 73 rotating plate, 74 mobile plate, 75 limit roller, 76 the second spring, 8 the third spring.

2.3. Implementation Methods

Lifting rail 1 is set in this improved design of lifting slide rail system for the stone processing machine. Lifting track 1 is sliding and lock-connecting with two set of the fixtures 2, which are of an inverted U structures and symmetrically located in the side of lifting trail 1. On the other side, in the fixture 2, the fixed block 3 is sliding and lock-connecting. And the outer wall of the fixed block 3 is fixed to the inner wall of the lift rail 1near the fixture 2. While the upper end of fixed block 3 is fixedly connected to the lower end of the hydraulic tappet 4. And its upper end is fixed to the first spring 5, a compression spring, and inside this spring, the slider 6 is set, whose height is less than the that of the first spring 5 in its normal state. Slider 6, a cylindrical structure, is slidingly lock-connected in the
fixture 2, and its lower end surface is in contact with the upper end surface of the hydraulic tappet 4. Besides, above the slider 6 sets a limit device 7. Since the lifting rail 1 is connected to the fixed block 3, by driving the hydraulic tappet 4, the lifting rail 1 can move upward and downward. Design of this kind is quite practical in actual scenario, especially when processing hard stone, lifting rail 1 will be subjected to a reaction force and then push the fixed block 3 upward, which consequently will push the hydraulic tappet 4 upward and compress the first spring 5. By this method, damage to the cutting tool and potential risky situations can be prevented from happening. Moreover, the limit device 7 includes a mobile block 71, whose lower end is fixedly connected to the upper end surface of the slider 6. And through limit base 72, the mobile block 71 slides and hinges with two sets of rotating plate 73. As to the rotating plate 73, it locates in the limit seat 72, while the other end of the rotating plate 73 is hinged with the mobile plate 74. The adjacent ends of the two sets of mobile plates 74 are fixedly connected to the two ends of the second spring 76 respectively. While the mobile plate 74 is slidingly located in the limit base 72. One end of the mobile plate 74 near the limit base 72 can be moved and lock-connected in the fixture 2. In addition, and two sets of limit rollers 75 are slidingly can slide and run through the mobile plate 74. The limit rollers 75 are fixedly connected to the inner wall of the limit base 72 at both ends, while the upper end of the limit base 72 is fixedly connected to the third spring 8, and the upper end of the third spring 8 is fixedly connected to the top of the fixture 2. The third spring 8 located on one side of the lifting rail 1. With respect to the mobile block 71, it is of cylindrical structure, whose diameter is smaller than that of the slider 6. The limit base 72 is located in the fixture 2. On the other hand, the length of the rotating plate 73 is larger than that of the mobile plate 74 residing in the fixture 2, whereas at one and the same time, the length of the rotating plate 73 is less than that of the mobile block 71. The mobile plate 74 is of a rectangular structure, whose length is less than one-half of the length of the limit base 72. The sliding distance of the limit roller 75 in the mobile plate 74 is greater than the length of the mobile plate 74 in the fixture 2, the aforementioned second springs 76 are consist of two sets, which are respectively located on the outside of the two groups of rotating plates 73. As matter of fact, both the aforementioned second spring 76 and third spring are extension springs. The third spring 8 is in the extension state when it is located in the fixture 2. Slider 6 moves downward due to its own gravity, in this process, it also pulls the mobile block 71, making it move downward as well; as a result, the mobile block 71 pulls two sets of rotating plate 72 to rotate on two sets of moving plate 74 respectively. The rotating plate 72 rotates to drive the mobile plate 74, rendering the second spring 76 is in a extending state. When the two groups of rotating plates 72 are on the same horizontal line, one end of which is located in the fixture 2, the elastic force entailed by the extension of the second spring 76 can strike a balance with the gravity of the slider 6, sliding block 6. Provided that the reaction force is excessively large, the slider 6 will push the mobile block 71 to move, the second spring 76 stops due to the gravity of the slider 6, then the second spring 76 will resume to its original state and pulls the mobile plate, through the limit roller 75, to move within the limit base 72. As to mobile plate 74, it will move to the side of the mobile block 71 so that one end of the mobile plate 74 and fixture 2 will be separate from each other. At the time, the third spring 8 will resume back to the original state, pulling the limit base 72 move upward, and consequently, limit base 72 will pull the first spring 5, hydraulic tappet 4 and fixed block 3 move upward, then make the lift rail 1 move upward. This is how the design can prevent the cutting tool and stone from contacting, further completely terminate the cutting work, i.e., it can ensure the safety of operation and avoid injury to surrounding personnel.

2.4. Working Principle
By and large, the improved design of the lifting slide rail for stone processing machine is as follows: lifting slide rail 1 is connected to the fixed block 3, by driving the hydraulic tappet 4 and moving the fixed block 3, the lifting rail 1 can move upward and downward. In the case when there are hard stones, lifting rail 1 is subject to a reaction force, pushing the fixed block 3 upward. While fixed block 3 will push the hydraulic tappet 4 move and compress the first spring 5, by this way, it can prevent the cutting tool from damaging, and decrease any potential risks. The slider 6 moves downward driven by its own gravity and pulls the mobile block 71. And the mobile block 71 moves downward too and pulls two sets of rotating plates 72 to rotate on two sets of mobile plates 74; at the same time, the
rotating plates 72 rotates to push the mobile plates 74, so that the second spring 76 is in an extending state. When the two sets of rotating plate 72 are located in the same horizontal line, one end of the mobile plate 74 is located within the fixture 2, the elastic force entailed by the tension of the second spring 76 is in a balance with the gravity of the slider 6. Provided that the reaction force is excessively large, the slider 6 will push the mobile block 71 to move, the second spring 76 stops due to the gravity of the slider 6, then the second spring 76 will resume to its original state and pulls the mobile plate, through the limit roller 75, to move within the limit base 72. As to mobile plate 74, it will move to the side of the mobile block 71 so that one end of the mobile plate 74 and fixture 2 will be separate from each other. At the time, the third spring 8 will resume back to the original state, pulling the limit base 72 move upward, and consequently, limit base 72 will pull the first spring 5, hydraulic tappet 4 and fixed block 3 move upward, then make the lift rail 1 move upward. This is how the design can prevent the cutting tool and stone from contacting, further completely terminate the cutting work, i.e., it can ensure the safety of operation and avoid injury to surrounding personnel.

3. Innovation in Structure

In contrast with the previous technology and structure, the improved design of the lifting slide rail system of stone processing machine has achieved the following innovations.

Firstly, as the lifting track is connected to the fixed block, the fixed block can be moved upward and downward along the lifting slide rail by driving the hydraulic tappet. Provided that the machine processes hard stone, the lifting trail is subject to reaction force and will push the fixed block upward; then the fixed block will push the hydraulic tappet to move upward, as a result, the first spring will be compressed. Structural design of this kind can further prevent damage to the cutting tool from happening and avoid any potential risks.

Secondly, in the case when the reaction force is way too large, the slider pushes the limiting device, while the limiting device will pull the first spring, driving the hydraulic tappet and fixed block move upward. As a result, the lifting trail will upward correspondingly, thereby avoiding contact between the cutting tool and the stone, i.e. the cutting work will be completely terminated. The utility model can prevent any potential harm to related personnel and with its handy operation and strong practicability, such utility model is easy to promote and use in a wider range.

4. Application

In order to study the crushing performance of the new and old slide rail devices combined with the stone processing machine, the block waste processing is used, and the content of the needle flake particles of (16~31.5) mm single-grain level, crushing indicators, etc. Comprehensive test evaluation .The shape of the crushed stone processed by the new and old slide rail devices in conjunction with the stone processing machine is shown in Figure 4, The test results are shown in Table 1. Through the test of the content of needle flake particles, it is found that the content of needle flake particles is too high for the crushed stone processed by the old slide rail device with the stone processing machine, which exceeds the technical requirement of the maximum 25% stipulated by the national standard. The crushed stone processed with the new slide rail device and the stone processing machine, the content of needle flake particles and the crushing index meet the requirements of the national standard. The new slide rail device effectively adopts the principle of impact crushing. Using its equal probability of "stone-on-rock" crushing mechanism at all angles in space, the crushed stone can maintain a good square shape with multiple small cross-sections. The large fracture surface is less, and the crushed stone has less smooth surface, which fully improves its crushing index. After testing, it is 7.2%, which meets the technical requirements of Class I crushed stone.
Table 1. Performance of crushed stone produced by different production lines

| production line                  | Particle grading / mm | Needle flake particle content(%) | Crush index (%) |
|----------------------------------|-----------------------|----------------------------------|-----------------|
| The old slide rail device        | 16~31.5               | 31                               | 9.3             |
| The new slide rail device        | 16~31.5               | 2                                | 7.2             |

Figure 4. Crushed stone processed by two kinds of slide rail devices with a stone processing machine

5. Conclusion

By improving the design of the lifting slide device of the stone processing machine and innovatively designing the lifting rail, the fixed block that is fixedly connected to the hydraulic tappet, the sliding block with the limit device and other parts, it can effectively avoid the damage of the tool, and at the same time the occurrence of dangerous situations is reduced, the safety during use is further improved, the injury to surrounding personnel is avoided, and the operation is simple, the practicability is strong, and it is easy to promote and use.

The improved design of the slide rail device and the stone processing machine are used to crush and process the block and flake stone processing wastes of various shapes. The needle flake particle content and crushing indicators of the processed crushed stone meet the requirements of the national standard. The crushing index is 7.2%, which meets the technical requirements of Class I crushed stone.

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