An Improved Hydraulic Driven Feeding and Loading Wagon

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Abstract. In the process of rapid development manufacturing industry, feeding and loading wagon plays an important role in the connection and switching of each industrial station. In this paper, a hydraulic-driven feeding and loading system is proposed, and the system scheme and structure are given. On the basis of it, the finite element analysis and verification of the support are carried out. The designed wagon not only saves manpower and material resources, but also improves the work efficiency to a great extent.

1. Introduction

With the development of manufacturing industry, how to further improve production efficiency is the key problem to be solved. Feeding and loading system plays an important role in the connection and switching of each station in the production line. In the process of material transportation, the loading system not only reduces the consumption of manpower and material resources, but also greatly improves the work efficiency. Traditional hopper vibration loading system can realize automatic positioning, but it is only suitable for small size and simple shape of workpiece. In this paper, an improved hydraulic loading system is proposed, which can be used in the case of complex workpiece shape and frequent start-up.

2. Scheme Design

Common loading systems are shown in Figure 1. The electromagnetic field between the core coil and armature is generated by electrification or power failure, which changes the magnetic force to produce vibration between the base and the groove. However, in the process of frequent vibration feeding, it is easy to cause fracture between grooves. When the workpiece size is large, the hopper vibration loading system is difficult to complete the feeding task. In addition, when choosing the scheme of automatic feeding system, the following problems should also be considered:
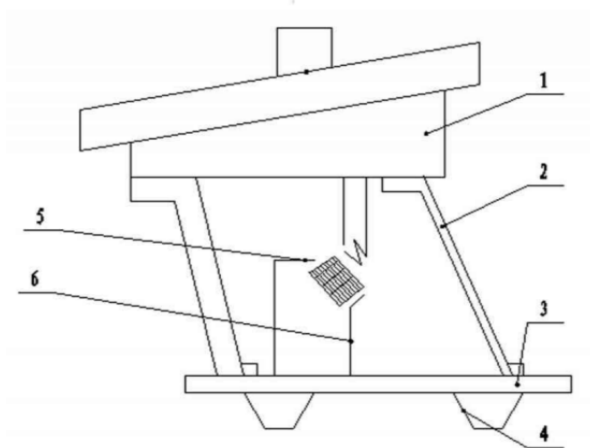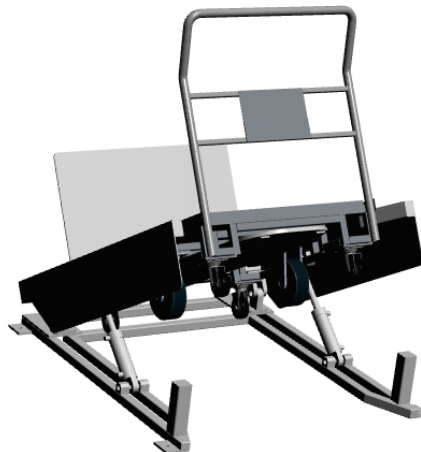
1. Groove body; 2. Leaf spring; 3. Base; 4. Shock-absorbing rubber frame; 5. Iron core coil; 6. armature; 7. Workpiece

Figure 1. Hopper Vibration Loading System

(1) The connection between automatic feeding mechanism and feeding system.
(2) The length of pipe and rod workpiece.
(3) Composition of brake mechanism and feed mechanism.

Figure 2. Hydraulic drive feeding system

According to the requirements, a hydraulic drive feeding system is designed as shown in Fig. 2. Among them, the hydraulic components are located in the overturning mechanism. In order to avoid the radial shear force generated in the processing or assembly process, the bottom cross beam is removed and the flat panel used to support the material box is replaced by a horizontal sliding plate. In this way, when the workpiece material box is lifted, the sliding plate can be directly inserted into the bottom of the car, the car can be lifted, and then the material can be reversed. After feeding, reset through hydraulic cylinder. The next feeding process is then carried out.

3. System Composition
The performance of the machine is mainly reflected in its efficiency. For the feeding process, the efficiency is reflected in the speed of feeding. When the material completes a process, it will be placed in the material box and transported to the next process area by trolley or forklift. After reaching the next process, the first step is to feed. In the actual environment, accidental operations may occur when

picking up materials. This also involves the safety protection of the machine. For the process of human-computer interaction, it is necessary to prevent accidental operation and take targeted measures to ensure the safety of personnel. Misoperation is usually caused by internal factors or by the operator. Therefore, safety device, automatic locking device and switch control should be considered in the design of feeding system.
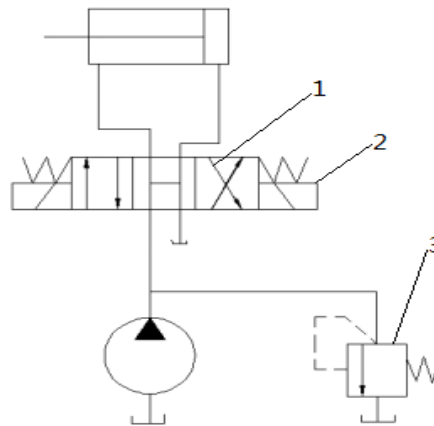
1. Three-position four-way commutation valve; 2. Electromagnet; 3. Overflow valve

**Figure 3.** Hydraulic Commutation Circuit

Because there is inclined ascent and descent process in the design of hydraulic system, considering the two cases of reversal and return, commutation circuit is needed. In the commutation circuit, the commutation valve is usually used to play the role of commutation. The selection of commutation valve needs to consider the rationality of the system. Commutation loops generally adopt the commutation mode of different executable components such as two-way four-way, three-way four-way or five-way commutation valves. Among them, the use of commutation valve is the most convenient one. The advantage of using solenoid valve for commutation is its fast action, but the disadvantage is that commutation has impact. The use of alternating current solenoid valve is another way of commutation, but this way is not suitable for frequent commutation operation. As shown in Figure 3, the circuit uses a three-way four-way electromagnetic commutation valve for commutation. Specific operation is: when the electro-hydraulic valve moves to the middle position, the piston is stationary and the hydraulic pump unloads; when the reversing valve is on the right or left side, the piston of the hydraulic cylinder will move to the left or right accordingly.

In the commutation loop, the bidirectional variable hydraulic pump can also be used to realize the commutation operation. The specific operation is: when the oil outlet on the left side of the bidirectional variable hydraulic pump is discharged, the piston of the hydraulic cylinder moves to the right; by adjusting the variable mechanism of the bidirectional variable hydraulic pump, the oil outlet on the right side of the bidirectional variable hydraulic pump is discharged, and the piston of the hydraulic cylinder moves to the left. Because of the advantages of three-way four-way reversing valve in reversing circuit, such as small leakage between oil outlets, reliable reversing, fast reversing speed and smooth impact-free reversing, the hydraulic commutation circuit shown in Figure 3 is adopted.
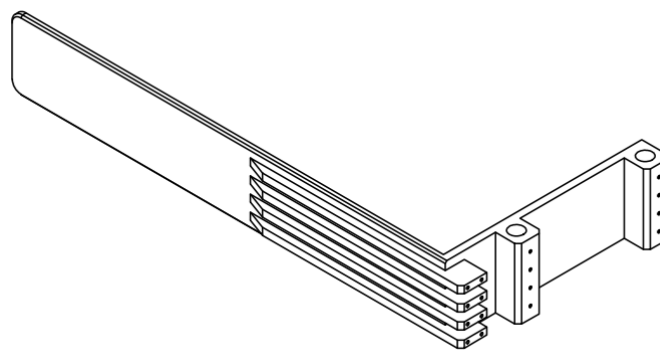
4. Support Analysis
Because the "L" sliding fork plate is very convenient to handle the workpiece and can be directly inserted into the bottom of the workpiece box, the "L" sliding fork plate is used as the support of the feeding rack. The "L" sliding fork plate can be divided into horizontal and vertical parts. The horizontal part is used to carry the material, and the vertical part is used to connect with the main body of the overturning feeder. For the vertical part of the connection between fork plate and the main body of the overturning feeding rack, there are two types: hook type and articulated type. The hook type is directly attached to the connected fork rack. Because the feeding rack

can realize the overturning motion, the hook type "L" sliding fork plate is not suitable. The articulated fork plate is provided with a pin hole in its vertical part. The pin hole can be connected with the supporting optical axis of the overturning feeding frame to realize the rotation around the axis, as shown in Figure 4.
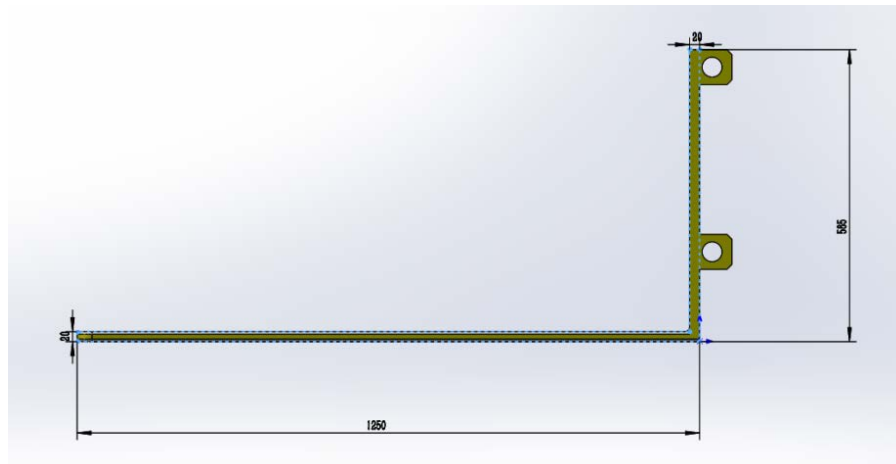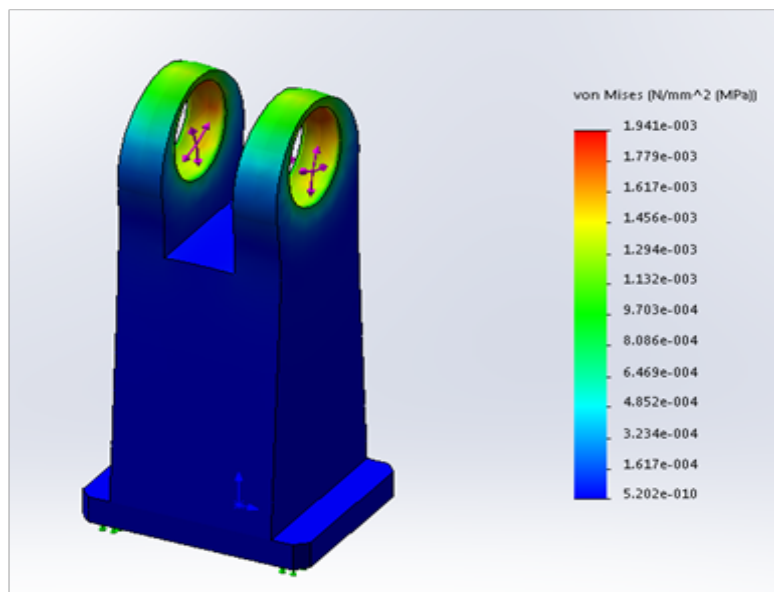

Figure 4. The "L" Sliding Fork Plate

The strength and stiffness of single sliding fork plate are not up to requirements. It can increase the thickness of the sliding fork plate or replace the material, but these two methods are not suitable from the cost point of view. Therefore, the strength and stiffness of the L-shaped sliding fork plate can be effectively improved by adding stiffeners to the bottom of the dangerous section of the sliding fork plate. The improved sliding fork plate is shown in Figure 5. Four stiffeners are added to the bottom of the horizontal part of the sliding fork plate. The strength and stiffness of the structure are calculated to meet the requirements.

Figure 5. Sliding Fork with Stiffeners

Figure 6. Analysis of Support Pedestal

The bearing connected with sliding fork plate should be analyzed because the support base connects the sliding fork plate with the loading system body. In the process of working, the support is always in the state of force, and the transmission of moment must be completed. At the hole-axle connection of the support seat, the stress distribution should be paid special attention. For this reason, a three-dimensional model as shown in Figure 6 is established by using the finite element analysis method. Taking into account the actual value, it can be found that the hole-axle connection of the support seat is the most concentrated position of the working load, and its value is less than the allowable stress value of the material, so it meets the requirements.

5. Conclusions

The main purpose of designing hydraulic loading system is to solve the problem of frequent manual operation of workpiece box in loading operation. In order to achieve the main functions required by the site, the driving mode and structure of the loading system were improved, including the determination of the overturning part of the feeding frame, the transmission part of the hydraulic mechanism and the support part. On this basis, the finite element analysis of key stress components is carried out. The results of calculation and practical application show that the hydraulic loading system can meet the requirements of production line and greatly improve the working efficiency.

6. References

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