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Design and Application of Automatic Variable Pitch Automatic Sleeve Replacement Device and its Automatic Mechanism for Cylinder Head Bolts

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Abstract: To realize the full automation of cylinder head bolt assembly. This paper designs a sleeve structure, sleeve automatic replacement device and bolt installation equipment to realize the efficiency, convenience and stability of bolt sleeve replacement. The production site has verified that the new device has effectively improved productivity efficiency and product quality.

1. Introduction

The sleeve is a common tool for all kinds of mechanical assembly, used to cover the head of the bolt and transfer the torque of the tightening tool, so that the bolt can tighten all kinds of assembly parts. When the bolts of different specifications are tightened, the sleeve of the corresponding specifications should be used. Usually, on a mechanical product, even the same part will use a multiple combination of bolts to tighten according to the reliability requirements. In this way, when the production efficiency is required, the speed improvement and convenience of sleeve replacement should be considered[1~4].

2. Design of the bolt installation equipment

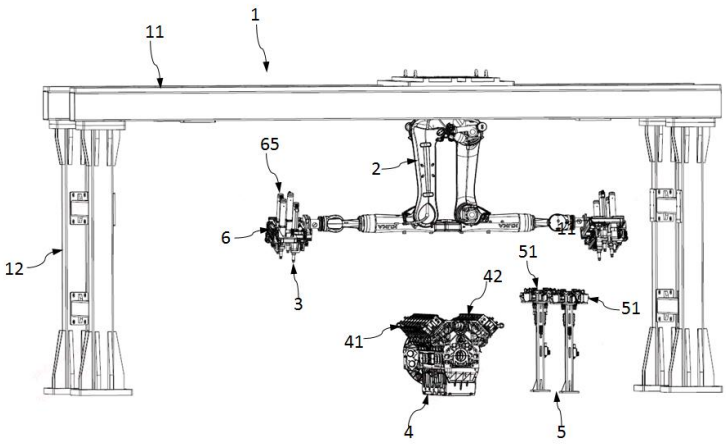

Figure 1: Schematic diagram of the bolt installation equipment structure

In view of the above deficiencies, this paper designs a bolt automatic installation equipment to improve the bolt assembly efficiency[5].

The equipment includes a bench, which includes columns on both sides and beams supported by both columns. Under the beams, robotic arms can be connected to one or more robotic arms[6]. As shown in Figure 1, the two robotic arms can also be connected to each other. The end of each mechanical arm is equipped with operation tools that operate the bolts through the sleeve structure to tighten the bolts and achieve the purpose of installation. At the same time, the bolts can also be removed.

3. Design of the bolt sleeve structure

The sleeve assembly includes the operating barrel portion and the connector body, at least part of the linker is inserted in the junction; The sleeve assembly also includes a lock-in ball, the transfer section is provided with the first bayonet, connecker set with through holes, the part of the locked ball can be located at the first bayonet, part is located in the through-hole, to lock the rotation joint and the connector body along the axial direction; The sleeve assembly also includes a core lock pin and an elastic portion, at least a part of the core lock pin is located within the connection and may move in an axial direction, the core lock pin is provided with a second bayonet; In the first state, the second bayonet and through-holes are staggered in the axial direction, the conflict between the outer surface of the core lock pin and the inside of the lock ball; In the second state, the second bayonet and the through-hole correspond in the axial direction, lock the ball away from the first bayonet, the part of the locked ball is located at the second bayonet, and the elasticity is compressed or pulled. The replacement of the sleeve structure is relatively stable[7~8].

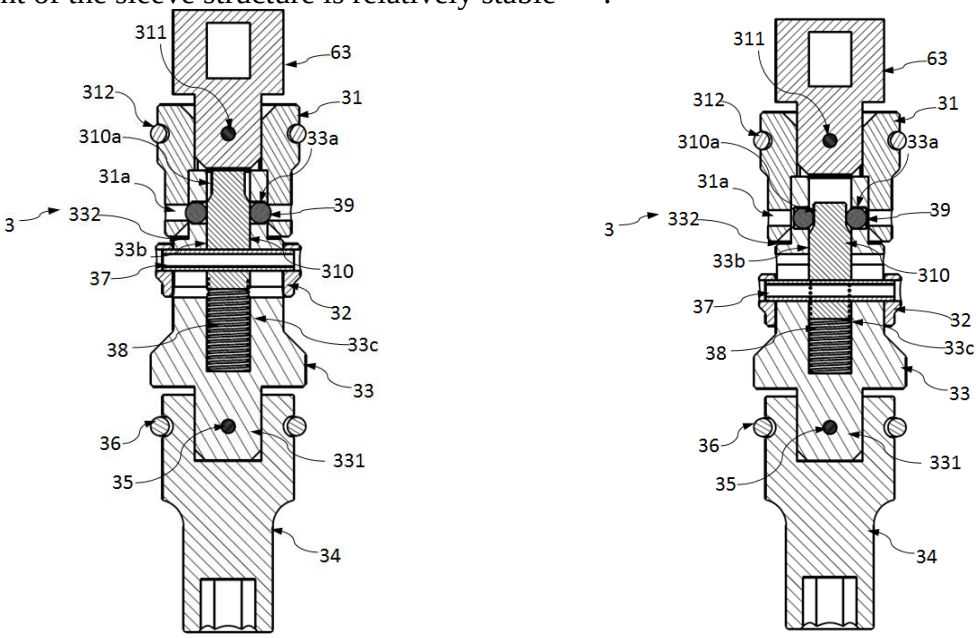

Figure 2: Structural diagram of the sleeve structure in the first state

In this design, the transfer joint is connected to the robotic arm. The sleeve assembly includes the operating cylinder part for matching with the bolts and a connecting body fixed or integrated with the operating cylinder part. Reassemble the transfer part and the corresponding specification sleeve assembly to form a new sleeve structure. The sleeve structure also includes a core lock pin and an elastic portion located in the inner cavity of the connector, and the outer surface of the core lock pin is provided with a second bayonet.

In the first state, as shown in Figure 2, the second bayonet and the through hole are staggered in the axis, and the outer surface of the core lock pin resists the inner surface of the locking ball, and the diameter of the locking ball is larger than the radial size, and the distance between the inner end of the through hole and the outer surface of the core lock pin when the lock hole is less than the maximum distance between the connector and the through hole.

In the second state, the core lock pin can be moved along the axial direction under the external force, so that its second bayonet and through hole correspond in the axial direction. That is, both are projected on a radial direction, at least partially overlap. In this way, the distance between the inner end of the through hole and the outer surface of the core lock pin is increased to allow a certain radial escape space so that the part of the lock ball can pass through the through hole inward and is located in the second clip. When the radial distance of the avoidance space satisfies that the locking ball moves inwards, the locking ball can be made to leave the first bayonet, then the connecting body and the connecting part are no longer locked by the locking ball axial limit. The connecting body and the connecting part can be separated axially, and the operating cylinder can be separated from the operating tool of the manipulator. At the same time, the elastic part is pressed or pulled, and when the external force is removed, the core lock pin can be reset to the first state[9].

4. Sleeve automatic replacement device

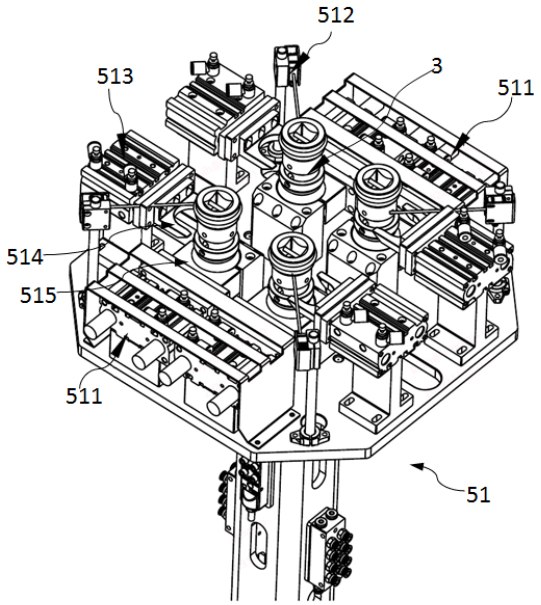

Figure 3: Schematic diagram of the sleeve automatic replacement device

The sleeve automatic replacement module is used to cooperate with the sleeve structure. The sleeve automatic replacement module includes an unlocking part, the unlocking part includes a drive structure and an unlocking structure for the drive unlocking structure to drive the core lock pin along the axis, as shown in Figure 3.

The mechanical arm carries the original transfer part to the position of another set of sleeve automatically replacing module. The driving structure drives the unlocking structure to approach the sleeve component on the sleeve module, drives the lock pin of the core to move axially, and the mechanical arm drives the knuckle to press down. The drive structure drives the unlocking structure to move near the lock pin of the core for unlocking, and the transfer part can move down to the first

clamping port and corresponding through hole. Then the drive unlocking structure moves backward to unlock, under the action of the elastic part, the core lock pin moves up, and pushes the lock ball outward so that its part falls into the first clamping port. The axial locking transition part and the connecting body are pulled upward by the mechanical arm to drive the sleeve structure of the specification to leave the group of sleeve automatic replacement modules. Thus, the sleeve structure of different specifications can be replaced.

5. Variable distance device

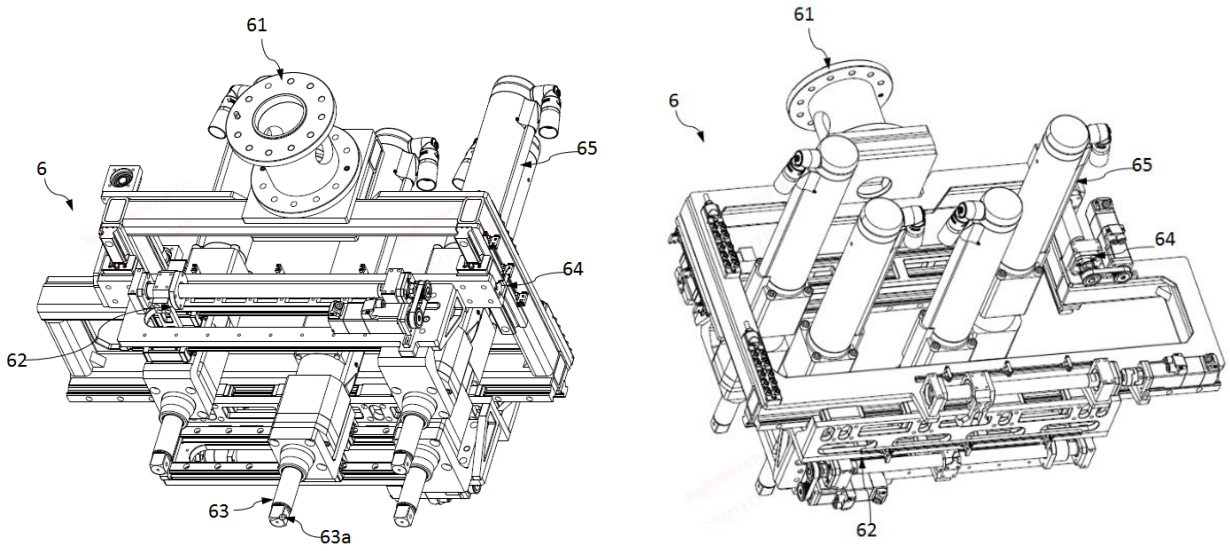

Figure 4: Schematic diagram of the variable pitch device;

The variable pitch device in this embodiment is equipped with two tracks, namely the first track and the second track, the first track can be moved along the second track under the action of the driving member, the operation tool is provided with an installation unit, the installation unit is used for connecting the transfer part, and the operation tool moves along the second track under the action of the driving member. It can be seen that a group of tracks of the variable distance device can drive the mounting part to move in at least two directions, and the two directions can be perpendicular to each other, such as in transverse and longitudinal directions, and under the driving part, the mounting part can drive the corresponding sleeve structure to move in the longitudinal and transverse directions, so as to adjust the spacing of the plurality of sleeve structures, as shown in Figure 4.

Three operation tools are equipped with a set of track, the three operation tools can be moved along the transverse and longitudinal, can form rectangular, diamond, parallelogram, trapezoid layout form, so as to adapt to the different spacing bolt layout requirements, torque gun installation set on the torque gun, torque gun on track, torque gun can tighten the sleeve structure.

6. Conclusion

According to the above design drawings, the automatic tightening machine of cylinder head bolt was made, verified by the production site, met the requirements of V-type and in-line models. After the implementation of the device, the production rhythm of cylinder head bolt station was optimized from 35 minutes to 20 minutes, and the efficiency increased by 40%; the labor intensity was greatly reduced, holding action to 0 times nearly 8 hours a day during the original operation, combining stations and reducing one operator; the quality hazard of leakage and inaccurate closing torque caused by manual negligence is completely eliminated, as shown in Figure 5.

Figure 5: Automatic tightening of cylinder head bolts for V machine

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