The design of dis-assembly and assembly vehicle for outdoor high voltage pillar insulator of substation

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Abstract. The overhaul of outdoor pillar insulators in substations plays an important role in the safe operation of the whole substation, ensuring the safety of power consumption and reducing economic losses. Because of its unique layout and special environment, the existing disassembly and assembly work is usually carried out by pure manual work. For this reason, this paper puts forward a design of disassembly and assembly vehicle specially for insulator disassembly and assembly, which can automatically realize disassembly, assembly and transportation and greatly improve the efficiency of operation. This paper mainly focuses on the design of its hydraulic system.

1. Introduction
The design of dismantling and assembling vehicle for outdoor high-voltage post insulators in substations is mainly based on the fact that there are few maintenance devices or some problems, and the overhaul of high-voltage outdoor post insulators is a very important link. Ensuring the normal working performance of insulators is very important and necessary for the whole circuit system. It can ensure the safe production of enterprises, avoid accidents, reduce casualties and economic losses.

At present, the disassembly and assembly vehicle of high-voltage outdoor pillar insulators is very few, so it can be regarded as a new topic. As far as the existing disassembly and assembly vehicle is concerned, there are still some problems which are not universally applicable. The disassembly and assembly of this kind of pillar insulator in many high-voltage outdoor substations are accomplished manually. Some use overhaul vehicles, this device also has the problem of inaccurate clamping position, low efficiency. Therefore, the development of new disassembly and assembly vehicles has great prospects for development.

2. Confirmation of integral structure of disassembly and assembly vehicle
The whole disassembly and assembly vehicle is designed to realize the functions of walking, lifting, turning, clamping and handling. From the appearance, the disassembly and assembly vehicle consists of three parts: working device, upper turntable and walking mechanism.

According to different functions, the hydraulic system of disassembly and assembly vehicle can be divided into three basic parts: working device hydraulic system, rotary device hydraulic system and outrigger hydraulic system. The working device of disassembly and assembly vehicle mainly consists of moving arm, bucket rod, gripper and corresponding hydraulic cylinder. It includes three hydraulic circuits: moving arm, bucket rod and gripper. The function of the rotary device is to turn the working device and the upper turntable to the left or right for clamping and unloading. The hydraulic component to complete the action is the rotary motor. When the rotary system works, it must satisfy
the following conditions: rapid rotation, no impact, vibration and swing of starting and braking. The disassembly and assembly vehicle designed in this paper should satisfy the requirements of not working and not turning when working. The function of the walking device is to support the whole quality of the disassembly and assembly vehicle and complete the walking task, using tire mechanism. The design of walking system should consider the problem of straight-line running, that is, if a certain work-load action occurs during the walking process of disassembly and assembly vehicle, it will not cause the phenomenon of walking deflection of disassembly and assembly vehicle [1].

When the disassembly and assembly vehicle needs to be disassembled and assembled, the disassembly and assembly vehicle should first run to the position where it needs to be operated, then extend the leg to ensure the stability of the whole machine, then connect the rotary motor and rotate the turntable, so that the working device can be transferred to the disassembly and assembly position. At the same time, the arm cylinder is operated, the hydraulic cylinder is extended by large chamber oil injection, and the power arm is raised to the position of the pillar insulator, then the bucket rod cylinder or clamp is operate Cylinder, so that the gripper clamping work. After clamping the post insulator, the gripper connects the rotary motor to turn the working device to the unloading position. Then the gripper cylinder and the bucket rod cylinder stop and operate the small chamber of the arm cylinder to feed oil, so that the arm drops, and then the gripper cylinder retracts, so that the gripper loosens the load post insulator. After the unloading is completed, the working device carries on the second disassembly cycle at the disassembly position.

Because of the limitation of outdoor substation layout, the road width is 1000 mm, so the body width of disassembly and assembly vehicle is preliminarily determined to be 800 mm. Because the total weight of the vehicle is lighter at full load, the ground of the substation is generally flat without gradient. In view of the above conditions, in order to save resources and protect the environment, the walking of disassembly and assembly vehicle can be fully driven by manpower.

3. Design of hydraulic system for disassembly vehicle

Because the designed disassembly and assembly vehicle belongs to small light-duty machinery. In order to make the structure compact, a single pump quantitative system is adopted.

3.1. Hydraulic system diagram

As shown in Figure 1, the hydraulic system of the disassembly and assembly vehicle transfers the power of the motor to the actuator such as the hydraulic motor and the hydraulic cylinder through the hydraulic pump, and promotes the action of the boom, bucket rod, gripper, rotary mechanism and supporting leg, thus completing various operations.

Figure 1. Sketch map of hydraulic system.
3.2. Composition of hydraulic circuit

1) Rotary circuit. The revolving circuit of the insulator disassembly and assembly vehicle is composed of a revolving control valve, a revolving hydraulic motor and a cushioning and repairing circuit. Because the revolving mechanism of disassembly and assembly vehicle works frequently, some special circuits are needed to meet the working requirements of revolving mechanism braking. The hydraulic system diagram of the rotary circuit is shown in Figure 2.

![Figure 2. Buffer circuit.](image)

Buffer circuit of rotary circuit: It consists of rotary control valve 1, buffer hydraulic valve 2, rotary hydraulic motor, unidirectional filling valve 4 and 5, among which 2, 3, 4 and 5 constitute rotary buffer circuit [2].

Braking circuit of rotary circuit: When the insulator is disassembled and assembled, due to the large moment of inertia of boarding, it will cause great impact in the hydraulic system when starting, braking and suddenly changing direction. This impact will cause vibration and noise of the whole hydraulic system and components, and even lead to damage of hydraulic components. So the buffer circuit of disassembly and assembly vehicle is to use the buffer valve to make the oil in the high pressure chamber of hydraulic motor exceed a certain pressure to get a way out. The revolving brake of the disassembly vehicle is controlled by the revolving control valve 1. The control valve returns to the middle position, the rotary hydraulic motor starts to brake, and the rotary braking moment is adjusted by the buffer valve 2. Hydraulic braking is adopted in this design, that is to say, to make the control valve return to the middle and cut off the hydraulic motor to enter and return oil to achieve the braking effect [3].

2) Control circuit of moving arm and bucket rod. As mentioned above, the disassembly and assembly vehicle designed in this paper belongs to light-duty and small-sized machinery, so it doesn't need to be as complicated as the hydraulic circuit of the excavator's boom and bucket rod. It only needs the boom and bucket rod hydraulic cylinder to be able to move normally.

3) Hydraulic control circuit of gripper. Like the hydraulic circuit of the moving arm and bucket rod, it is necessary to set up a locking circuit for the hydraulic control circuit of the clamper, so as to ensure that the clamper hydraulic cylinder is in a fixed position when it holds the insulator in the process of handling.

4) Sequential loop and locking loop of outrigger: Because the disassembly and assembly vehicle designed in this paper is limited by working conditions in the process of operation, in order to ensure the stability of the machinery, a leg support device is specially set up. The requirement for outriggers is that when the outriggers are extended, they should not retract, soften or move under the action of external load, so the locking circuit should be set up to complete the outriggers.
3.3. Working process of hydraulic system

When the disassembly truck runs to the working position, before the disassembly and assembly work is officially started, the leg should be extended first, and the leg should be extended sequentially. As shown in the Figure 3, the left position of the hydraulic cylinder of the front leg should be connected by the manual double-connected multiplex valve A, so that the hydraulic cylinder of the front leg can be extended while the locking circuit is locked, and then the left position should be connected by the manual double-connected multiplex valve B, so that the hydraulic cylinder of the rear leg can be extended and locked at the same time. Loop locking: After the rear leg is extended, the pressure oil discharged from the hydraulic cylinder of the leg comes to the manual four-way multi-way valve. At this time, the left position of the reversing valve C is connected, and the rotary hydraulic motor starts to work. At the same time, the oil inlet of other actuators (arm cylinder, bucket rod cylinder, clamp cylinder) is cut off, so that other actuators can be prevented from working with the rotary hydraulic motor at the same time [4]. When the working mechanism rotates to the working position, make the middle part of the reversing valve C connected. At this time, cut off the motor oil intake and other actuating elements oil intake connection. By manipulating the reversing valve D, E and F, the movable arm cylinder, bucket rod cylinder and clamp cylinder can be expanded and expanded. It should be noted that when the clamp cylinder drives the connecting rod to clamp the post insulator, it needs to carry the clamp, so it is necessary to carry the clamp. The hydraulic cylinder is locked.

When the disassembly and assembly vehicle completes the operation, control the reversing valve to make the arm, bucket rod and gripper return to the original position, and then control the reversing valves A and B, so that the leg can be retracted.

4. Problems existing in disassembly vehicles

Because of the special environment of high-voltage outdoor substation, the working environment of disassembly and assembly vehicle is limited. There are great requirements for the shape of the whole disassembly and assembly vehicle, which requires compact design structure and space saving. However, the use of hydraulic system in disassembly and assembly vehicle will make the overall structure not too compact and increase the size of the whole machine. In addition, the main components of the hydraulic system of construction machinery are the transmission system and the
working device parts. When the transmission power and control are realized by the working device, leakage and energy loss usually occur. Most of the causes of the transmission system failure are caused by the pollution of hydraulic oil, and the common fault feature of them is the insufficient pressure of the system [5]. These problems will increase the maintenance work of disassembly and assembly vehicles. Compared with the regular insulator disassembly and assembly work, this hydraulic drive makes it necessary to maintain disassembly and assembly vehicles regularly, and relatively increases the workload.

5. Conclusions
In this paper, a design idea of disassembly and assembly vehicle for outdoor high-voltage post insulators in substations is proposed, and the possibility of disassembly and assembly vehicle is preliminarily given. The design of disassembly and assembly vehicle is helpful to improve the efficiency of disassembly and assembly of post insulators in substations, but there are also some problems that need to be solved further.

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