Development of special tools for maintenance and testing of substation primary and secondary equipment

Liwei Zheng *, Wei Wang, Mingjun Liu, Long Li, Honglei Li, Haoye Tian
State Grid Jilin Electric Power Company Limited Baishan Power Supply Company, Baishan, Jilin, 134300, China
*Corresponding author’s e-mail: 983720738@qq.com

Abstract. In order to improve the work efficiency of the first and second overhaul of the substation, and to ensure the personal safety of the staff, this paper proposes a retractable test line box for secondary maintenance and a V-type porcelain column break insulation protection frame for isolation control of primary equipment. The wire box can effectively shorten the time of test wiring and make the on-site debugging work more convenient. The insulation frame guarantees personal safety. The retractable test line box and the isolating switch V-type porcelain column broken insulation protection frame can be used to improve the efficiency of the first and second on-site inspection and debugging, and effectively protect the personal safety of the staff.

1. Introduction
First of all, with the continuous development of smart grids, the application of intelligent substation microcomputer protection optical tester is becoming more and more popular. The use of the intelligent substation microcomputer protection light tester makes the field relay protection debugging work more convenient. However, the problems associated with the connection, placement, and storage of the corresponding test fibers were followed. Before each experiment, it is necessary to connect the optical fiber of the optical tester, including the optical tester end and the backside of the protective screen protection device. Different types of optical fibers are used according to the model of the back panel optical port of various models. During the connection process, the optical fiber cannot be placed neatly and orderly. If it is necessary to find the connected optical fiber, it is inconvenient to check. After the test is completed, it is necessary to disassemble the various optical fibers and arrange them into the test line package. At the next test, they are connected and repositioned as before. In this way, when working in the field, the testers need to reconnect, arrange, and place the various functional optical fibers every time. The staff is prone to problems such as the wiring affecting the test process, resulting in test errors and affecting the smooth progress of the work. [1-2]

Secondly, there are a certain number of V-type porcelain column isolation switches in the currently operating substation. Due to the long running time of the switch and the aging of the porcelain column, the occurrence of multiple types of porcelain column fractures poses a great threat to people and equipment. [3]

In order to solve the above problems and improve the work efficiency of the first and second overhaul, it is urgent to design a convenient test line box for secondary maintenance and an insulation protection frame for one-time maintenance.
2. Telescopic test line box principle and structure

The new test line box designed in this paper is a fiber storage device in which the optical fiber can automatically expand and contract inside. The device can be directly applied to the relay protection test, and the test fiber can be stretched or shrunk according to the needs of the test, so that the optical fibers of various models and functions are isolated from each other without interference.

The external structure diagram of the retractable test line box is shown in Figure 1. See Figure 1, 1: box handle, 2: box cover, 3: box, 4: box lock, 5: fiber optic telescopic lock button, 6: pigtail outlet, 7: fiber protection cover, 8: Fixed shaft, 9: fiber, 10: fiber head.

![Figure 1. Retractable test line box external structure diagram](image1)

![Figure 2. Retractable test line box internal structure diagram](image2)

The retractable test line box consists of 9 parts, which are box, box handle, box cover, box lock, pigtail outlet, fiber optic telescopic lock button, fiber protection cover, fixed shaft, and box internal reel.

The reeling shaft is set on the fixed shaft, and there are 8 reeling shafts. The optical fiber with different specifications can be installed according to the site requirements. The optical fiber has a fiber expansion port extending. One end of the optical fiber is connected to the relay protection tester, and the other end is connected to the test device. The length required for the expansion and contraction of the optical fiber can be tested according to the test requirements, and the length of the optical fiber expansion and contraction is fixed by the optical fiber telescopic locking button. After the test, the optical fiber is retracted by the internal spring of the winding shaft. A net pocket is placed on the lid to place a light pen, an optical power meter, and a spare fiber.

On-site work, such as the use of intelligent substation retractable fiber test chamber, at the end of each test, the test fiber will shrink, each fiber will be independent of each other, and will not cause the test pigtail to knot and stagger. It is easy to organize and reduces the time wasted in the early stages of the test. The test fiber is made beautiful and neat.

3. Principle and structure of insulation protection frame

There are also a number of isolation switches for the type of porcelain columns in the substation currently in operation. Due to the long running time of the switch and the aging of the porcelain column, the occurrence of multiple types of porcelain column fractures poses a great threat to people and equipment. In order to ensure that the workers are not threatened by the fracture of the porcelain column during normal operation, the “insulation protection frame for the isolation switch type porcelain column break” was developed.[4-6]

The design has four advantages: 1. Epoxy insulation frame, the main structure is simple, the bearing capacity is strong, the main body is made of epoxy resin insulation material, and the main body of the protection frame can be decomposed and conveniently stored and used. 2. The universal wheel can conveniently control the movement of the protection frame in the work site. 3. Silkworm mesh, made of insulating material. 4. The insulated protective frame of the isolating switch type porcelain column needs two butt joints, and the metal connecting fixture is used. Fig. 3 is a schematic structural view of an insulating frame.
Figure 3. Insulation frame structure diagram

See Figure 3, the parts name is as follows: 1. Epoxy resin tube insulation frame. 2. universal wheel. 3. silkworm wire mesh. 4. metal connection fixture.

Referring to Fig. 3, the insulation protection frame of the V-shaped porcelain column of the isolation switch comprises a desktop insulation frame composed of an epoxy resin tube. The main body structure is simple, the bearing capacity is strong, and the main body adopts an epoxy resin tube insulating material, which can be decomposed and conveniently stored and used. There are four universal wheels in the lower part of the insulating frame, and the surface of the insulating frame has a slanted silk screen.

The protective frame is used in combination with two butt joints (single in Fig. 2) to form a mesh-shaped table top for easy access, and the metal connecting clips are connected during docking for easy fixing. The universal wheel can support the entire insulation protection frame and facilitate the movement of the protection frame within the site. The silkworm mesh is made of insulating material. When the isolating switch breaks down, the silkworm wire mesh catches the falling isolation switch to prevent discharge to the ground. Since the falling direction of the isolating switch is not necessarily the same, it is necessary to use two "insulation guards for the isolation switch type porcelain column break" to be docked, and the two "isolated switch type porcelain column broken insulation guards to be docked by the metal connecting fixtures" "fixed. At the same time, the isolation switch can be prevented from breaking and the protective frame can be pushed down after falling.

4. Conclusion

For the maintenance work of primary and secondary equipment, there are problems of low work efficiency and hidden dangers in personal protection. In this paper, a retractable test line box for secondary maintenance and a V-type porcelain column break insulation protection frame for isolation control of primary equipment are designed. It has been proved by practice that the special tools for substation primary and secondary equipment maintenance can effectively improve the efficiency of the first and second overhaul work and ensure the personal safety of the staff.

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