Application and Future Development of Aviation Cable Inspection Technology

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Abstract. Aviation cables are crucial for the transmission of electrical signals between aircraft systems, and the use condition of aviation cable is strict and the quality requirement is high. However, due to environmental and human factors, aviation cables often make many mistakes during manufacturing, posing a threat to the quality of cables and the safety of aircraft. Based on this situation, this paper studies three kinds of aviation cable detection technology, and puts forward the specific methods of how to optimize the detection means in the future, in order to improve the reliability of aviation cable, and this paper also conducts research on aviation cable detection technology.

Keywords: aviation cable; inspection technology; application

1 Introduction

A large number of aviation cables are intricate connected to each other to form the aircraft neural network, that is, the aircraft electrical circuit interconnection system, which enables airborne equipment to transmit signals to each other to achieve system functions. The schematic diagram of the aviation cables is shown in Figure 1.

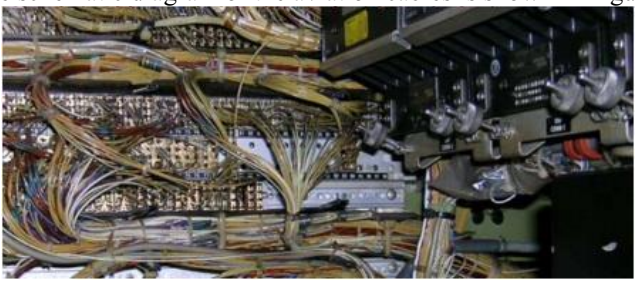

Fig. 1. Schematic diagram of aviation cables

Aviation cables are assemblies of any number of wires, electrical cables and groups and their terminations and wiring devices which is designed and fabricated so as to allow for installation and removal as a unit. Aviation cables contain several additional

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components such as connectors, splices, terminals, etc. Aviation cable assembly is shown in Figure 2, its main function is to transmit electrical current and in some cases electrical data and information throughout all the different elements of an aircraft. There are many different types of aviation cables and the difference it is mainly due to its function and application.

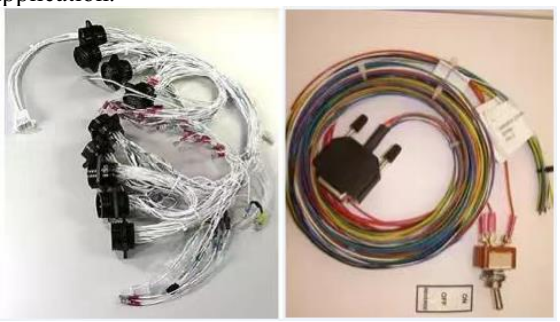

Fig. 2. Aviation cable assembly

2 Aviation Cable Inspection Technology

Aviation cables are important components for ensuring the normal operation of aircraft. Due to the strict usage conditions and high quality requirements of aviation cables, the manufacturing of aviation cables must meet the principles of minimum contact resistance and high mechanical strength of wires and components. The use environment of aviation cable is more complex, and it is easy to be affected by humidity, high temperature and vibration, resulting in the decline of insulation performance,cable life shortened,obstruction of conduction, distortion of data transmission and so on.[1-2] In order to ensure the normal operation of aviation cables, detection technologies need to be applied, mainly including detection of line faults, insulation resistance, component combination logic function detection, and electronic component assembly quality detection. At present, the following three aviation cable technologies are widely used: manual testing of cables, program control testing of cables, and automatic testing of cables using microprocessors.

The manual inspection of cables uses the original physical current detection method. Nowadays, there are many kinds of aviation cables and the use environment is harsh. Although manual testing is relatively simple, it consumes a lot of manpower, and it is also easy to cause errors. [3] Manual detection is the process of dividing cables into equal length sections, treating each section of the cable as a wire. If measuring a wire, the positive end of an ammeter can be used to output current, and the negative end can be used for current detection. This detection method requires a sensitive ammeter to be connected to the cable, and the current status of the cable can be observed through the indication of the ammeter. If the tested cable is a bundle of wires, we still use a segmented measurement method to conduct conductivity and insulation resistance tests on the cable. The manual detection method also has certain drawbacks. This method can detect a large number of open circuit faults, while a small number of short circuits,

string faults, and other faults are not obvious, which may create safety hazards. The program control detection of cables takes a bundle of cables as a detection unit and considers it as a whole containing many wires to check for any open circuit in the cables. The advantage of this detection method is that there is no need for repeated testing during the inspection, and only one inspection is required for each section of the line, which can detect the continuity and insulation of the cable. [4-5] In addition, in order to program control cables, program control testing requires drawing drawings to study the circuit before testing, and then programming based on scientific principles to achieve automatic testing. Therefore, the quality of programming directly affects the efficiency of testing. The microprocessor automatic detection technology for cables adopts a point detection method, using each detection point as the detection primitive to detect the cable. By detecting the signal between two points, determine the cause and location of the fault. This detection method is relatively simple, has high universality, and will not cause damage to the circuit. The main content of aviation cable detection technology is to detect the circuit, and the main software for detection is the detection program and detection table. The detection program is relatively universal and convenient to use.

The common faults of aviation cables mainly include scratches or breaks on the outer skin of the wire, broken wires in the core of the wire, damage to the shielding layer of the wire, and defects in the insulation layer of the wire that lead to burning. The content of aviation cable testing technology mainly includes: testing whether the cable harness and network assembly are correct, testing the insulation performance of the cable harness and network, and testing the shielding of the cable wire harness and network.

Firstly, in order to check whether the cable harness and network assembly are correct, it is necessary to check whether there is an open circuit in the circuit, whether there are errors, omissions, excessive or virtual connections of wires, and whether there are incorrect wiring such as shrinking pins. At the same time, attention should be paid to checking the correctness of the assembly position, whether various connectors meet the design requirements, and whether the component dimensions are correct. Secondly, for the inspection of the insulation performance of cable wire bundles and network, the key is to test the insulation of each wire of the cable, as well as the insulation of the shielding layer and aircraft shell, and ensure that its insulation resistance value meets the original design requirements. Finally, the testing of cable harnesses and network shielding requires no damage to the shielding layer, good contact with the plug-in, and the overall shielding effect and wire core shielding effect can meet the requirements of the original data. Then comes the monitoring of cables and all accompanying components in the network, including switches and buttons, meter heads and buses, resistors and capacitors, diodes and voltage regulators, etc. The main technical indicators of the wiring harness tester testing system are shown in Table 1. Aviation cable testing includes conductivity testing, voltage withstand testing, etc.

Table 1. Main technical indicators of the wiring harness tester testing system

Conduction detection	DC5Vmax, ± 5%; 1mAmax, ± 1%; 50 Ω~1k Ω (default 500 Ω), ± 10%;
Voltage withstand test	AC50V~500V, accuracy ± 5%;
Insulation detection	DC50V~750V, insulation resistance 10K Ω~1000M Ω;
Resistance measurement range	1 Ω~1M Ω;
Instantaneous break test	Instantaneous break detection width 200ms

3 Application status of aviation cable inspection technology

Through the above analysis, it is not difficult to find that various environmental and human factors in the current aviation cable application technology can cause problems in the cable during operation. In order to ensure the normal operation of the aircraft, it is necessary to conduct testing before cable assembly. The quality of cables can have a direct impact on the operation of aircraft, and may even cause safety issues. [6] Therefore, cable manufacturers attach great importance to cable testing projects and have established professional testing departments to ensure the high quality of cables through various scientific and technological means.

Due to technological and self limitations, China's current aviation cable inspection technology is relatively backward. Most of the methods use manual inspection to detect each section of cable section by section, which not only has low accuracy but is also easily affected by human factors. Taking the manual inspection of helicopters as an example, the pre flight cable inspection time can be as long as about three days, after installation, a cable inspection will be conducted for about five days, which will have a negative impact on the economical operation of the aircraft. Although many manufacturing units have adopted semi-automatic cable detection devices, the scope of use of these devices and the technical means of professional personnel are still at a relatively backward level in the world. [7] Therefore, it is necessary to effectively develop China's cable detection technology.

At present, China also conducts the whole machine cable automatically by introducing foreign automatic conduction equipment, automatic conduction technology is a multi-disciplinary technology, including electronics and electrical, mechanical systems, computer control and so on, [8] which includes automatic conduction measurement and resistance automatic measurement, insulation test between cable and electronic components, automatic testing of cable voltage resistance, capacitance and relay, etc., which basically covers the needs of most of the cable testing of the whole machine, so as to reduce the cost of investing a lot of manpower in complex testing. At the same time, it can greatly reduce the risk of missed detection and misdetection.

The key to the lack of self-developed automatic connection equipment in our country lies in the inability to design the transfer cable. The transfer cable is the key bridge connecting the harness end linker of the airborne equipment and the connector at the end of the leading equipment. The linker at the end of the equipment is a fixed shape, while the connectors at the end of the airborne wire harness are in various forms, round or rectangular, single or double row, and of different shapes and sizes. Connector interfaces of various shapes need to be designed to meet different requirements, and there is still a lot of room for improvement in this regard.

The layout and connection of the entire cable detection system on the machine are shown in Figure 3. The following figure shows the distribution of aircraft aviation cables.

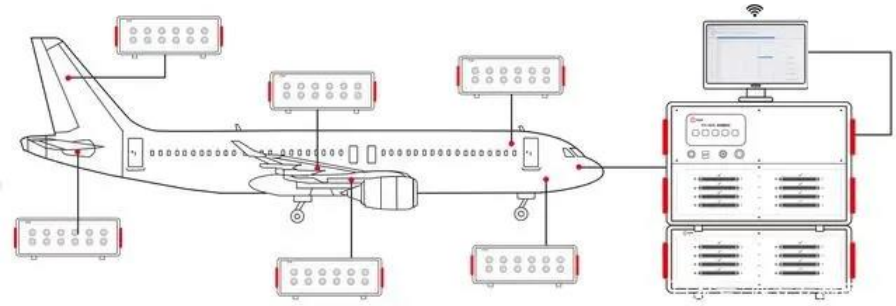

Fig. 3. Schematic diagram of the layout and connection on board of the entire aircraft cable detection system

4 Future Development of Aviation Cable Inspection Technology

The future development trend of aviation cable detection technology is to follow program control and achieve automatic detection through program control to ensure the efficiency of detection technology. The current program equipment for cable testing is equipped with a detection state that carries testing software. By connecting it to a computer, the tested cable can be tested. The program control detection method still needs to be achieved through continuous experimentation and practice, conducting continuous experiments in a single model of the aircraft model, and promoting it in various aircraft models. The widely used testing equipment in China currently includes MPT-5000 cable detector, MNTS bus testing equipment, and power box dedicated test bench, which can effectively achieve programmed testing of cables. The detection point of the MPT-5000 cable detector is 1500 points, which only takes a few seconds to detect. However, in the process of manual detection, this is a very large workload. This method can not only improve work efficiency but also ensure the accuracy of the work. However, the corresponding database for the measurement has not yet been created completely, and further improvement is needed. The MVTS bus testing equipment is applied to detect the structure of the MIL-STD-1553B bus cable dielectric network and network topology.

During the process of program monitoring cable testing, strict testing steps need to be followed in order to ensure the orderly and efficient conduct of the entire testing activity. The first step is to establish a wiring harness connector database by drawing the root cable wiring harness. The second step is to establish a table corresponding to the address of the measuring point and the address of the wire harness pin, and to make the necessary adapter cables for testing based on the corresponding table content. This step is the most important part of the entire testing process. The third step is to write a testing program, confirm that all hardware and software designs are correct, verify accuracy, and correct errors. Step 4: Write supporting testing process documents. Step 5: After conducting the test, store the test history data of the wiring harness. Strictly following these five steps for program monitoring cable detection can ensure that all data

inside the aircraft is connected to the database of the cable control system and effectively transmitted. Finally, in order to ensure the reliability of the technology, the testing technology needs to be verified repeatedly to ensure that the testing process does not affect the normal operation and safety of the aviation project. At the same time of development, it is also necessary to select the testing technology that is most suitable for the current development of China's aviation cable industry.

5 Conclusion

At present, the application of aviation cable detection technology is developing rapidly, and its comprehensive development is the main development trend of current detection technology. On the basis of traditional detection technology and new detection technology, this paper puts forward a set of complete program monitoring cable detection method, which can effectively test the connectivity of aviation cable. To a certain extent, it ensures the safety and reliability of cable transmission, so as to achieve a leap in the testing level of aviation cable.

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