International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 6 Issue 8 Ver. II ǁ 2018 ǁ PP. 03-05

Mechanical Design Of Testing System Of Multi Working Positions' Switch

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ABSTRACT:*Aiming at the problems of low automation, low efficiency and poor precision in the test of aviation electrical appliances, a multi-station toggle type avionics switch test system was designed and developed byusing the new cam mechanism, the mechanical actuator of the toggle switch was designed, and the 3D model was established in Solidworks to realize the movement of 4 switches.*
KEY WORDS:*cam mechanism design, mathematical modelling, 3D design*

Date of Submission:17-10-2018 Date of acceptance: 03-11-2018

I. INTRODUCTION

Aviation electrical switches are used as high-frequency aerospace components and are often installed on various control panels and used to turn the circuit on or off to achieve the corresponding functions.However, the current technology for the test of avionics switches remains in the manual operation and push-type switches. Jiang Yuanyuan[1] developed a test system for the fatigue life of button-type low-voltage switches, using ADAMS for mechanical to simulate the stability of the structural motion. Tang Jing[2] designed an experimental keyboard switch fatigue life test machine, which uses the motor to drive the eccentric wheel to rotate and simulate the finger pressing the keyboard to test the mechanical life of the push-type keyboard switch.

Therefore, based on the analysis of the working principle and technical indicators of the multi-station toggle switch, this paper designs and develops a test device from mechanical structure to provide a practical method to the development of Chinese aviation electrical testing equipment.

II. MECHANICAL DESIGN

Torealize the test of the switch, a test system was designed and developed by a mechanical actuator. While, mechanical device includes four parts: switch, mechanical drive, switch installation, mechanical frame, etc. The principle is that the motor drives the reducer, and the rotary cam rotates through the gear pair to drive the push rod to move back and forth, thereby realizing automatic togglethe switch.

2.1 Mathematical Modelling

The toggle of the switch is achieved by cam motion, so the design of the cam is particularly important, which determines the distance and force of the push rod. Before designing the cam curve, you first need to determine the maximum distance the pusher will push. As shown in Fig. 1, the maximum angle at which the switch handle can be pulled is 19°, and the length of the handle is 23 mm. Therefore, the maximum distance that the handle is pushed by the push rod is about 7.4 mm, considering that some of the switches are not automatically return back to the midpoint, so the maximum distance of the push rod should be pushed out twice than the original distance.

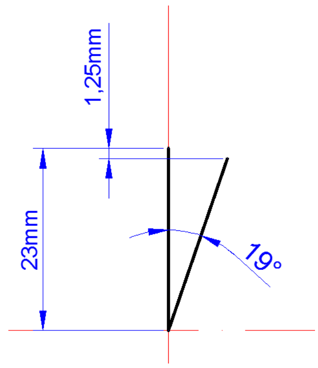

Figure 1 Concept of switch handle thrust design

Under the premise of satisfying the above conditions, the contour curve of the cam is designed based on the kinematic equation of the direct acting cam. Due to the particularity of the design, the cam curve design can also be designed according to the trajectory of the follower. According to Fig. 2, the cam profile curve is the same as the roller centre running trajectory. Therefore, based on the fifth-order polynomial motion law, the roller follower is a cam mechanism which is suitable for high-speed operation. The equation for establishing the push period motion is:
[3],
which, the boundary condition is when ， s=0， v=0， a=0. While, when， s=h,v=0,a=0 , where 'h' is the maximum stroke of the follower and '' is the time.

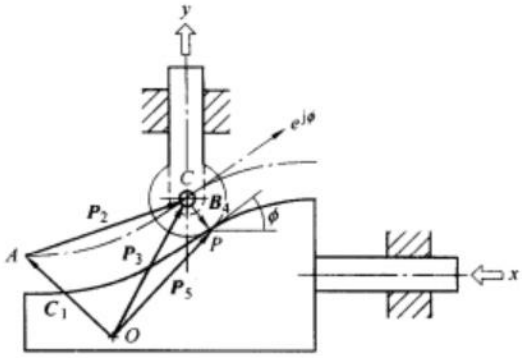

Figure 2 Design of round-end follower linear motion cam curve [4]

2.2 Simulation

With the change of time, rotation angle and the requirements of the commissioning unit, it is assumed that the time required for the push period is 2.75s, and when the maximum displacement of the push rod is 15mm, the motion curve of the follower is obtained by using MATLAB, as shown in Figure 3 below, which are time about displacement, velocity and acceleration. Since the acceleration curve in Fig. 3 has no sudden change in value and the amplitude is small, the simulation result is theoretically applicable to the design.

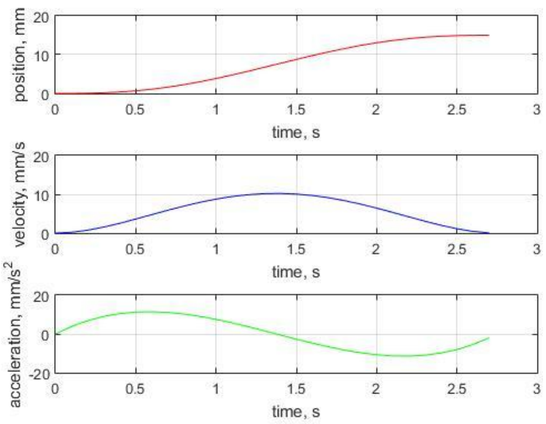

Figure 3 Follower motion chart

According to the displacement curve diagram in Fig. 3, the independent variable "time" is converted into the angle of the cam rotation in unit time, and the "pointing method" is used to realize the transformation of the cam curve from the theory to the Solidworks physical map, and the design of the single cam three-dimensional (Figure 4).

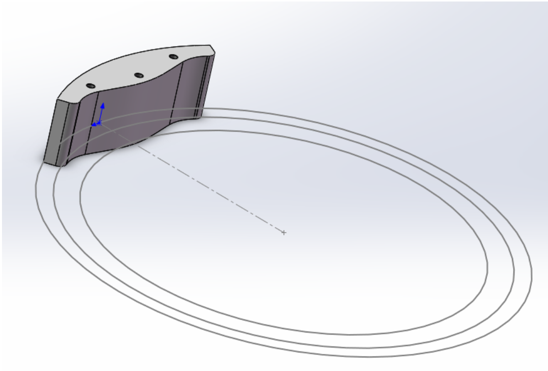

Figure 4 3D part design of the cam

To realize the pushing of the switch handle, install two cams onto a cam rotating disc and sequentially pushes the end of six push rods.Therefore, six (three sets) push rods are designed, each pair having an angle of 180° and fixedly mounted on the push rod mounting plate.

2.3 Final Design

To realize the measurement of multiple switches, the mechanical execution structure shown in Figure 5 is designed. The motor drives the reducer, and then the pinion on the reducer drives the two large gear discs under the left and right rotating components to rotate, thereby driving the left and right rotating cams. The rotation of the disc enables the three-position interval to push the switch handle and push back to achieve the switch reset. In order to meet the requirements of measuring four switches at the same time, the left and right rotating components are designed as upper and lower layers, and a total of four cam rotating disk.

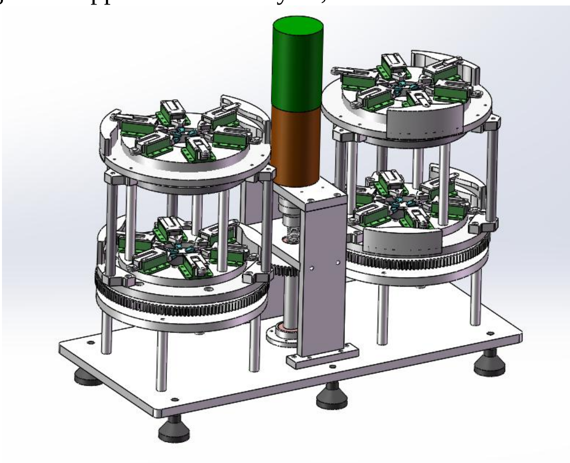

Figure 5 Model of mechanical structure in three dimensional

III. CONCLUSION

The mechanical design of the testing system is important as initial design of the whole system. It improves the testing efficiency, low down manual working load and higher the testing accuracy as well, which achieved design goals and will provide good example as reference to other designers in the future.

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Shen Yi-Chun "Mechanical Design Of Testing System Of Multi Working Positions' Switch "International Journal of Research in Engineering and Science (IJRES), vol. 06, no. 08, 2018, pp. 03-05