

Development and Applications of 3-position Enabling Switches Embodying Operation Safety based on Ergonomics

Yoshio Sekino, Takao Fukui, Noboru Sugimoto* and Toshihiro Fujita

IDEC IZUMI CORPORATION, 1-7-31, Nishimiyahara, Yodogawa, Osaka 532-8550, Japan

* The University of Kitakyusyu, 1-1, Hibikino, Wakamatsu, Kitakyusyu, Fukuoka 808-0135, Japan

Highly automated control systems still involve many situations where the operator directly interacts with the machine. When the operator has to work in hazardous areas, safety for the operator must be given the first priority. To prevent hazards, various standards such as ISO12100, IEC60204-1, and ANSI/RIA R15.06 stipulate the necessity of enabling devices. This paper reports 3-position enabling switches of the slow action and snap action types developed for ensuring safety from an ergonomics point of view to meet the requirements described in these standards. Photographs of wide variety of these components including grip switches are shown in Fig.1.

The 3-position type enabling switch is indispensable to secure ergonomic safety as stipulated in IEC60204-1 and ANSI/RIA R15.06. In terms of dynamic characteristics, conventional pushbutton switches are classified into the slow action type in which the travel of the actuator button has a linear relationship with the contact movement and the snap action type in which the contact snaps open or close when the button is pressed to a certain depth. We have developed these two types of 3-position enabling switches with their typical operating characteristics shown in Fig. 2.

Teaching operation of robots, for example, often takes a long time and up to one whole day in the longest case. While concentrating on the actual teaching operation, the operator may lose consciousness of the enabling switch, resulting in decrease of operating force (loose gripping) or increase of operating force (excessive gripping). Because of these reasons, the 3-position enabling switch must meet two requirements from an ergonomic point of view; (1) light operating force at position 2 and (2) sufficient difference in operating force during transition from position 2 to position 3. The slow action type has a light operating force of approximately 3N at position 2 and a high operating force of approximately 15N for transition to position 3, where direct opening action is employed to open the contact as shown in Fig. 2 (a). The snap action type has an operating force of approximately 3N at position 2 and a still higher operating force close to 30N for transition to position 3 as shown in Fig. 2(b). Both types satisfy the tactile feedback required for 3-position enabling switches described above.

This paper reports detailed investigation results from the viewpoint of ergonomics and usability of 3-position enabling switches including grip switches and pendant type control terminals used for robots and machine applications.



Fig.1 Photographs of enabling devices

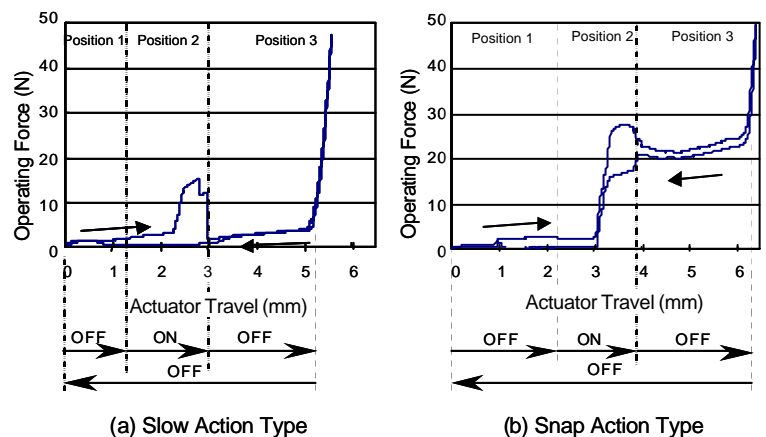


Fig.2 Switching characteristics of 3-position enabling switches