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The New Structure Design and Simulation of Preventing Electric Shock Multi-Jacks Socket

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Abstract: To meet consumer demand for safe, durable, attractive appearance and easy to use, the design is an improvement and innovation in appearance and structure of the multi-jacks, multi-functional, intelligent, environmental protection and others socket for preventing from electric shock. The new multi-jacks socket has the properties of electric shock prevention, automatically incorporating wires, jacks in different directions, beautiful appearance, and it can be the decoration of home space.

Keywords: Preventing electric shock, multi-jacks socket, structure design, simulation, mathematics analysis.

1. INTRODUCTION

Socket is a very common power connection. It is because of commonplace, we often easily overlook its potential security risk. According to "China Statistical Yearbook fire" and other relevant information, electrical fires occurred in China each year accounted for more than 30% of the total annual fires, and most of the electrical fires caused by the poor quality switches and sockets.

With the improvement of the condition of the family, and the increasing use of household appliances, many families prefer multi-jacks socket because of its being multi-purpose. But since the jacks of multi-jacks socket are generally not all be used simultaneously, the spare jacks will be a threat to the children at home. Because the children are born with good move and have a desire to explore everything, they may put the nail or finger into the spare jacks causing an electric shock. The lengthy wires of multi-jacks socket can provide the convenience of use, but it can also cause problems. For example, the jumbled wire not only impedes the cleaning, but also it is difficult to place. In addition, the jack spacing of existing multi-jacks socket is designed unreasonably. When we insert a large plug into a jack, the large plug will occupy the adjacent space and the adjacent jack will not be used. This article mainly discusses the adaptive innovation design, which is based on TRIZ theory [1] and is used for solving the above problems.

2. APPEARANCE DESIGN OF NEW MULTI-JACKS SOCKET

2.1. Appearance Shape of New Multi-Jacks Socket

Fig. (**1**) illustrates the overall appearance shape of the new multi-jacks socket. It is similar to starfish with six horns. There is a jack in each horn, six jacks in total. Each jack is surrounded with a circular light which can change color from green to red with the electrical power of the electric equipment which is inserted in the jack. The greater the power the more the red, green color change corresponding to the unused state. The shape, similar to starfish, breaks the previous regulation rectangular square shape, and achieves different direction of jacks. The new multi-jacks socket has a rounded platen on the top and a master switch to control on/off. There is a translucent protective cover over each jack. Through the translucent protective cover, internal structure of jack can be seen from the outside.

2.2. Appearance Color of New Multi-Jacks Socket

Color is an important factor for appearance design, because color can directly affect the purchase intent of consumers or users [2]. In order to match the psychological needs of customers and adapt to the color of the home space, the new multi-jacks socket is designed in fresh and bright colors. In this article, the color is described by CMYK. As shown in Fig. (**1**), main color of the new multi-jacks socket is white (C:0,M:0,Y:0,K:0); translucent protective cover is blue (C:99,M:77,Y:0,K:0, Transparency:50%); rounded platen and master switch are red and purple(C:49,M:71,Y:0,K:0) respectively.

3. STRUCTURE DESIGN AND SIMULATION OF NEW MULTI-JACKS SOCKET

The new multi-jacks socket is mainly composed of switch, rounded platen, winding plate, translucent protective cover, socket cap, preventing electric shock device and back cover. The assembly of these structures follows modular design principle and can be realized by DIY disassembly or assembly [3].

3.1. Structure of *Preventing Electric Shock* Device

As shown in Fig. (**2**), ***preventing electric shock*** device is mainly composed of spring 1 1, spring 2 2, jib 3, stent 4,

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Fig. (1). Overall appearance renderings.

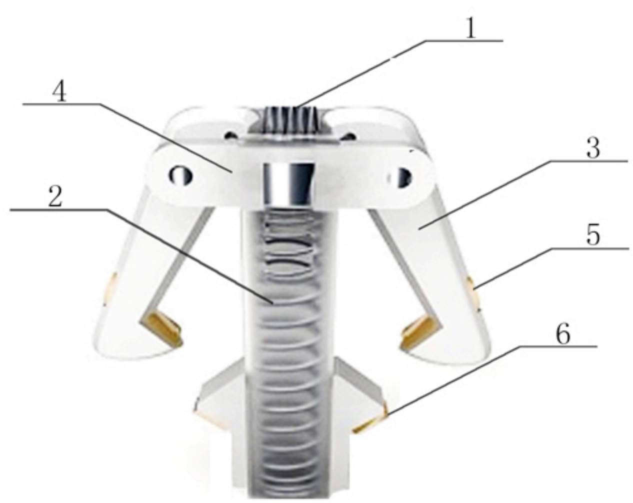

Fig. (2). Preventing electric shock device (main structure).

conductive connection block 5, conductive strip 6. The operation principle of ***preventing electric shock*** device is: when an object like a nail or other conducting object is inserted into a hole of jack, due to contact with point between object and jib, the object is easy to slip and cannot contact with the conductive strip. The object cannot be charged. Even without slipping, since there is a unilateral force on jib, so that jib will be rotated to the upper plastic body of conductive strip and be forced to stop. The jib can neither move downward nor rotate. The conductive connection block cannot contact with the conductive strip, so the object will not be charged too. When two objects like nails or other conducting objects are inserted into the two holes of jack at the same time, due to the instability of a child holding small items like nails, the two jibs of ***preventing electric shock*** cannot move down at the same speed, in the same direction and at the same time, which means the stent will be inclined. At this time, the jibs will bounce back under the action of the elastic force of the spring1, so the objects cannot be contacted with the conductive strip and electric shock accident cannot occur. However, when a plug is inserted into the jack, because of that the movement of plug is restricted by jack shape, the plug will only move down and not offset. So, two metal strips of plug will stably move down along the jibs to contact with conductive connection block until the elasticity of spring 2 reaches the maximum. Then, the two jibs will rotate in the opposite direction to respectively contact with conductive strips and the plug is electrified, as is shown in Fig. (**3**). Since the conductive connection block is inserted and fixed on jibs and through jibs, when the jibs connect with the conductive strips, it is the conductive connection blocks that contact with conductive strips directly. When plug moves away from outlet, due to elasticity of the spring 1 and spring 2, jibs will revert to the initial state.

Fig. (3). The conducting state of preventing electric shock device.

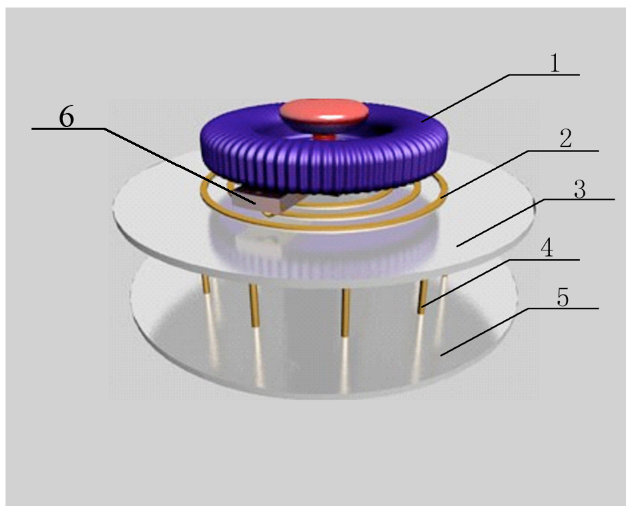

Fig. (4). Winding plate (main structure).

Fig. (**2**) shows that there is a certain inclination angle and distance between conductive connection block and conductive strips. If the downward movement process of plug does not reach the predetermined depth, the plug is not energized. That is to say, we will not be shocked even if we pull or insert the plug directly holding the metal strips of plug. It is very convenient and safe for those who like to operate plug using a single hand.

3.2. Structure of Winding Plate

Winding plate is located in the central part of the new multi-jacks socket. Fig. (**4**) illustrates the structure of winding plate. It is mainly composed of reel 2, rounded platen 1, upper chassis 3, winding rods 4, bottom chassis 5 and electric brush 6. The function of winding plate is to automatically incorporate the wire. Reel 2, which is made from metal and pressed against upper chassis 3, will be energized and turned when electric brush 6 is pressed down and contacted with it by the rounded platen 1. The frictional force generated by reel 2 on the upper chassis 3 will cause the entire mechanism consisting of the upper chassis 3, the winding rods 4 and the bottom chassis 5 to rotate. Thus the power wire of new multi-jacks socket is rolled in the winding rods 4.

4. MATHEMATICAL MODEL OF THE PRESSURE DISTRIBUTION OF PREVENTING ELECTRIC SHOCK DEVICE

In order to ensure the feasibility and stability of preventing electric shock device, it is necessary to analyze the forces on the device and make a mathematical analysis. The Fig. (**5**) illustrates the every force which acted on the preventing electric shock device. In order to make conductive connection block contact with conductive strip successfully, the stent must be always in the horizontal state. That is, in the

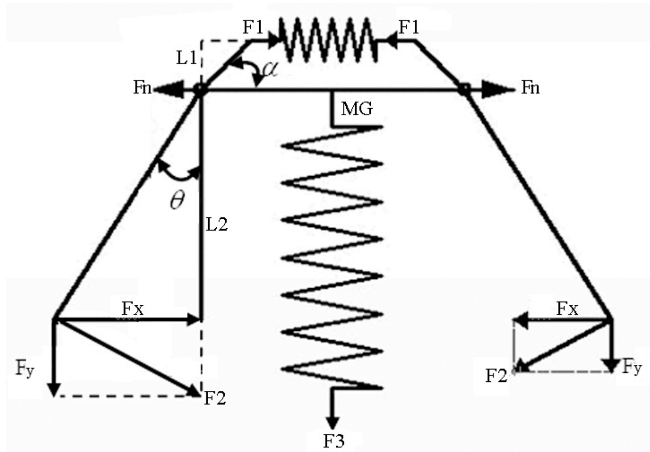

Fig. (5). Every force which acted on the preventing electric shock device.

process of inserting plug into the jack, the two jibs must move down in the same speed. So, spring 2 and spring 1 cannot start deforming at the same time. Spring 1 cannot work until the elasticity of spring 2 reaches the maximum. This requires the elasticity coefficient of spring 2 and spring 1 meets a certain proportion.

In Fig. (**5**), some symbols are expressed as follows:

F_1 --- the elasticity of spring1, N;

F_3 --- the elasticity of spring2, N;

F_2 --- the force on the jibs, N;

*F*n --- the force on the stent, N;

MG --- the gravity of spring 1, spring2, jib, stent, and conductive connection block, N;

α --- the angle jibs and stent, Degree

θ ---the angle between jibs and spring2, Degree;

L1 --- the distance from spring1 to stent, *mm*;

L2 --- the distance from the bottom endpoint of jibs to stent, *mm*.

Some of them can be expressed by equations, as follows:

$$F_2 * \frac{L_2}{\cos\theta} = F_1 L_1 \quad (1)$$

$$2F_2 * \sin\theta + MG = F_3 \quad (2)$$

$$F_1 = k_1 * X_1 \quad (3)$$

$$F_3 = k_3 * X_3 \quad (4)$$

where,

k_1 --- the elasticity coefficient of spring1;

k_3 --- the elasticity coefficient of spring2;

X_1 --- the stretched length of spring1, *mm*;

X_3 --- the stretched length of spring2, *mm*.

Use of Equation (1)-(2), we have:

$$F3 = 2\frac{F_1 * L_1}{L_2}\sin\theta * \cos\theta + MG \quad (5)$$

Equation (5) shows that F_2 does not affect the function realization of the preventing electric shock device. It indicates that the quality of plug has no influence on the whole mechanism. Thus, the stability of preventing electric shock device can be guaranteed.

According to the condition which must be satisfied to realize the mechanism principle, and simulation in PRO/E software, we get some physical figures as:

M=0.96g, $\theta = 30^o, \alpha = 45^o\ L_2 = 7.3mm, L_1 = 2.5mm\ \ X_1 = 0.7mm$ $X_3 = 1.9mm$. Use equation (3)-(4) and put these figures into Equation (5), we get:

k3 / k1= 11.3 (6)

From Equation (6), we know that the function of preventing electric shock will be achieved as long as the coefficient ratio of spring 2 and spring1 is 11.3.

CONCLUSION

Aiming at these problems such as poor efficiency of preventing electric shock, easily tucking in motion mechanism and conductive failure of existing multi-jacks socket, the design provides a new preventing electric shock multi-jacks socket based on respecting the children's behavior rule. The new multi-jacks socket is designed as an innovative preventing electric shock device by increasing a winding plate, which can automatically incorporate the wire; and added with a LED light that its color can change with the power of electric equipment. From the above-mentioned content, the new preventing electric shock device has the operability and superiority. And by mathematical analysis and computer simulation, it is shown that the function of new multi-jacks socket is normal and stable so long as the coefficient ratio of spring 2 and spring1 is 11.3.

CONFLICT OF INTEREST

The author confirms that this article content has no conflict of interest.

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