

PUSH-BUTTON OPERATED ROCKER SWITCH

FIELD OF THE INVENTION

This invention relates to electrical switches and, more particularly, to push-button operated electrical switches. More specifically, this invention relates to push-button switches comprising a rocker switching mechanism.

BACKGROUND OF THE INVENTION

Electrical switches are essential, if not indispensable, in electrical applications such as electrical appliances, apparatus and installations. Among the various type of known switches, push-button switches and rocker switches are probably the most widely used. A rocker switch typically comprises a rocker member which can be toggled between at least two alternative stable operating positions corresponding to different alternative operation modes. A push-button switch typically comprises a linearly actuated push-button which is operated by a sequence of simple linear motions, e.g. by pushing down and then releasing a push-button.

Push-button actuated switches comprising a rocker-type switching mechanism are known. However, the actuation force characteristics of known push-button actuated rocker switches are not satisfactory due to the inherent actuation force characteristics of a rocker switch. For example, as can be seen from Fig. 1A which shows a characteristics actuation force diagram of a conventional rocker switch such as that shown in Fig. 1, a stepped actuation force has to be applied in order to overcome the inertia of a spring biased rocker member which is typically an integral part of a rocker switch. A resistive force, which results as a reaction to the actuation force, will be felt by a user. This resistive force will disappear well before the rocker switch has moved into the next stable operation mode due to the inherent spring bias of the rocker switch.

Push-button actuated switches with a rocker switching mechanism as the switching core are also known. In this specification, such switches will be referred to as a "push-button actuated rocker switch" for convenience. A conventional push-button actuated rocker switch comprises an actuation push button which is spring biased such that the push button is returned to its spring neutral position after each operating push. The push button is typically designed so that the push button will encounter the rocker member after it has travelled for a pre-determined distance towards the rocker.

When the operating modes of a conventional push button actuated rocker switch are to be changed, a user will have to push the push-button until the rocker switch is toggled. Typically, the initial push is light and smooth and the initial resistive force experienced by a user is an incremental resistive force of the biasing spring. After the push button has travelled for a predetermined distance, it will encounter the rocker and the inertia of the rocker will have to be

overcome if the rocker is to be driven into the next operating mode. At this encounter, the user will detect an abrupt increase in resistive force. The resistive force due to the rocker will gradually decrease and will disappear when the rocker has reached a critical threshold position beyond which the rocker will automatically move into the next operating mode without requiring further or additional toggling forces.

This abrupt or stepped increase of resistive force characteristics gives a user a rugged feel which is frequently disliked. Therefore, it will be desirable if switches which mitigate the aforementioned rugged feel can be provided. As most switches are to be fitted on fixtures, such as sockets or wall-plates, of a standard- or a predetermined size, it would be of additional benefits if switches with improved actuation feel can have a compact design so that the improved switches can be fitted on existing or standard fixtures. However, as a rocker switch is operated by toggling a rocker member about its pivotal axis while a push button is typically a linearly moving device which is movable along a longitudinal axis which is substantially orthogonal to the pivotal axis of the rocker member, providing an interfacing means or mechanism between the push button and the rocker switch while maintaining a compact design poses a challenge.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide push-button actuated rocker switching means, especially push-button actuated rocker switches with resistive force characteristics which alleviate shortcomings of conventional designs. It is also an ancillary object of the invention to provide a drive interfacing means or mechanism for operating a rocker switch by a push button. At a minimum, it is an object of this invention to provide the public with a useful choice of electrical switches with a push-button actuated rocker switching mechanism.

Broadly speaking, this invention teaches a push-button actuated rocker switch comprising a drive conversion means which converts a push-button motion into a reciprocating motion for driving a rocker switching mechanisms and provided with improved resistive force characteristics.

Accordingly, there is provided an electrical switch which comprises a push-button, a rocker switching mechanism having a rocker member, resilient urging means, and drive conversion means for converting motion of the push button into motion suitable for changing the operation modes of the rocker switching mechanism, wherein, the drive conversion means operates as an interface between the push-button and the rocker member whereby switching modes of the rocker switching mechanism can be changed by the drive conversion means in response to motion of the push button, the resilient urging means is disposed between the push-button and the rocker switching mechanism and is adapted for providing a resilient resistive force against motion of the push button towards the rocker member, for returning the push button towards a

spring neutral or zero displacement position and for providing an additional resilient resistive force to the drive conversion means whereby differential actuation force required to overcome inertia of the rocker member in order to bring the rocker member into a switching motion is reduced.

5 Such a resilient urging means operates to help to reduce the apparent height of the step of actuation force required to overcome the inertia of the rocker switching mechanism in order to bring the rocker member into toggling motion. The resilient urging means facilitates this by gradually increasing resistance before the rocker member is encountered.

10 Preferably, the resilient resistive force exerted by the resilient urging means on the push button is incremental when the push-button is moving from the zero displacement position towards the rocker member, the rate of increase of the resilient resistive force is higher when the push button is nearer the rocker member and is lower when the push button is nearer the zero displacement position. The two-stage resilient resistance force will provide a user with a useful indication or feedback of how close the push button is to the toggling position.

15 Preferably, the additional resilient resistive force of the resilient urging means operates to return the drive conversion means towards a neutral position which is away from the position at which the switching mode of the rocker switching mechanism will toggle.

20 Preferably, the additional resilient resistive force is positive when the push button is moving towards the rocker member and before the drive conversion means encounters the rocker member, the resilient resistive force is negative after the drive conversion means has encountered the rocker member and after inertia of the rocker member has been overcome. The negative force helps to return the drive conversion means and the push button to its zero-displacement position, since, once inertia has been overcome, the feel of an actual resistance is no longer important for most practical purposes.

25 Preferably, the resilient resistive force is negative and decremental after inertia of the rocker has been overcome but before the rocker member is driven into a position at which switching mode changing will occur without additional external actuation force.

30 In a preferred embodiment, the drive conversion means comprises a pendulum member which is pivotally movable about a pivotal axis, the pendulum member comprises a drive head which is pivotally movable about the pivotal axis between positions at which the switching modes of the rocker switching mechanism change. The pendulum member is at its pivotal neutral position when the push button is at its spring neutral position. At this pivotal neutral position, the pendulum member is intermediate positions at which the rocker switching mechanism will toggle.

35 Preferably, the pivotal axis of the pendulum member is substantially orthogonal to the direction of movements of the push button.

In a preferred embodiment, the resilient urging means comprises primary and secondary resilient urging means, the primary resilient urging means is adapted for returning the push

button towards its spring neutral or zero displacement position and the secondary resilient urging means is adapted for returning the drive conversion means towards a pivotally neutral position which is intermediate positions at which the switching modes of the rocker switching mechanism will be changed by the drive conversion means.

5 Preferably, the secondary resilient urging means begin to participate to provide additional resilient resistive force to the push button after the push-button has moved for a predetermined displacement from a neutral position towards a toggling position but before the drive conversion means encounters the rocker member, the toggling position is one at which no further external force is required to change the operation modes of the rocker switching mechanism.

10 Preferably, the urging resistance against motion of the push-button towards the rocker member is incremental after no additional force is required to change the operation modes of said rocker switching mechanism.

Preferably, the resilient urging means comprises first and second spring urging means, the first spring urging means operates to return the push button to its zero displacement position and the second spring urging means is adapted for exerting urging resistance against the push-button after the first spring urging means has already acted against the push-button for a pre-determined displacement towards but before reaching a position at which the operating modes of the rocker switching mechanism are changed.

15 Preferably, the first and second spring urging means are adapted for providing incremental resistance against said push-button when the push-button is moving towards a position at which the operating mode of the rocker switching mechanism are changed and before resistance of the rocker switching mechanism is encountered.

20 Preferably, the resistive force of the first spring urging means is reactive and substantially parallel to direction of the applied actuating force of the push-button, the resistive force of the second spring urging means is at an acute angle to the applied actuating force.

25 In a preferred embodiment, the first spring urging means comprises a pair of resiliently deformable legs which are substantially symmetrically disposed about the axis of the push-button and which provide a resistive force against the linear actuation motion of the push-button.

30 Preferably, the second spring urging means is resiliently deformed away from the rocker member of the rocker switching mechanism after the drive conversion means has encountered the rocker member and the resilient deformation of the second spring urging means operates to resist pivotal movement of the drive conversion means after the push-button has moved for a pre-determined displacement towards the rocker member.

35 Preferably, the drive conversion means comprises a pendulum-like driving member or pendulum member having a pivoted end and a swivable end, the swivable end of the driving member is pivotally movable relative to the pivoted end, the swivable end of the driving member and the rocker member of the rocker switching mechanism are co-operatively configured so that when the pivoted end of the driving member is moved towards the rocker member in response

to actuation motion of the push-button, the swivable end will be rotated towards a actuation position, whereby said the rocker member will be driven towards a position at which the operation modes of the rocker switching mechanism will be changed.

Preferably, the rocker member is pivotally movable about a rocker axis, the rocker member
5 comprise a pair or protruding arms which are symmetrical about the rocker axis, the pendulum-like driving member comprises a pair of driving heads which are symmetrical about the pivoted end, the driving heads of the drive conversion member and the protruding arms of the rocker member are arranged so that the protruding arms of the rocker member are alternatively driven by the corresponding driving heads for toggling the operating modes of the rocker switching
10 mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the present invention will be explained in further detail below by way of examples and with reference to the accompanying drawings, in which:-

15 Fig. 1 is a cross-sectional view showing the internal structure of a conventional rocker switching mechanism when subject to an actuation force F_N ,

Fig. 1A is a force-displacement diagram illustrating the actuation force required to toggle the rocker switching mechanism of Fig. 1 into a next operating mode with reference to the downward displacement of the actuation force,

20 Fig. 2 is an exploded view showing the more important parts of an electrical switch of a first preferred embodiment of this invention,

Fig. 2A is an enlarged perspective view of a first example of a suitable resilient urging member for use in the preferred embodiment of Fig. 2,

Fig. 2B shows a second example of a suitable resilient urging member,

25 Fig. 2C shows a third example of a suitable resilient urging member,

Fig. 2D shows a fourth example of a suitable resilient urging member,

Fig. 3 shows a cross-sectional view of the switch of Fig. 2 when assembled and in its first operating mode with the push-button in its zero-displacement position d_0 and subject to an actuation force F ,

30 Fig. 3A is a perspective view of the switch of Fig. 3,

Fig. 4 shows the switch of Fig. 3 with the push-button displaced downwardly for a distance d_1 from the zero-displacement position, at this position, a driving head of the pendulum-like driving member is just in contact with a protruding arm of the rocker member and Fig. 4A is a perspective view of the switch of Fig. 4,

35 Fig. 5 shows the switch of Fig. 3 with the push-button at a displacement d_2 , at this position, the driving member has reached a position at which it encounters a secondary returning

resistive force from the resilient urging member but is still in contact with a protruding arm of the rocker member and Fig. 5A is a perspective view of Fig. 5,

Fig. 6 shows the switch of Fig. 3 with the push-button at a displacement $d_2 + \delta$, at this position, the rocker member is just about to rotate into the next operating mode even without externally applied actuation force and Fig. 6A is a perspective view of Fig. 6,

Fig. 7 shows the switch of Fig. 3 with the push-button at a displacement d_3 , at this position, the rocker member is half-way to the next operating mode, and Fig. 7A is a perspective view of Fig. 7,

Fig. 8 shows the switch of Fig. 3 with the push-button at a displacement d_4 , at this position, the rocker member has reached the next operating mode and Fig. 8A is a perspective view of Fig. 8,

Fig. 9 shows the switch of Fig. 3 with the rocker switch in the second operating mode and the push-button returned to its zero displacement position,

Fig. 10A is a force-displacement diagram of a conventional push button rocker switch showing the applied actuation force with respect to the entire travel range of the bush-button,

Fig. 10B is a force-displacement diagram showing an exemplary force-distance characteristic due to a first spring urging means of a resilient urging member of Fig. 2A,

Fig. 10C is a force-displacement diagram showing an exemplary force-distance characteristic due to a second spring urging means of the resilient urging member of Fig. 2A,

Fig. 10D is an exemplary force-displacement diagram showing the resultant actuation force of a switch of this invention and the individual resistive forces of the rocker member and the spring urging means of the resilient urging member,

Fig. 11 is an exploded view showing a switch of a second preferred embodiment of the present invention,

Fig. 12 is a cross-sectional view showing the switch of Fig. 11 with a contact actuation member in its initial stable position and the push button at a spring neutral position,

Fig. 13 shows the switch of Fig. 12 with the contact actuation member moved to a position whereby the driving member is rotated to a position so that it begins to act on the rocker member of the rocker switch,

Fig. 14 shows the switch of Fig. 13 with the contact actuation member moved to a position whereby the driving member is rotated to a position so that it is acted on by a resilient return force due to a second resilient urging means of the spring urging member,

Fig. 15 shows the switch of Fig. 13 with the rocker member rotated into the next operating mode by the driving member consequential to the downward movement of the push button contact actuation member, and

Fig. 16 shows the switch of Fig. 15 with the push button returned to the neutral position of Fig. 12 but with the rocker member toggled to the next operating position.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A typical rocker switch 100 is shown in Fig. 1. The rocker switch comprises a rocker member 110 and a switching mechanism. The rocker member is configured and disposed so that it can drive a movable electrical contact of the switching mechanism into at least a first operating position and a second operating position so that first and second alternative connections can be made. Of course, rocker switches can have more than two operating modes. The rocker member 110 is pivotally mounted about a rocker axis 130 and is under internal spring bias so that, once the rocker member is moved to a critical threshold position, the internal spring bias will cause the rocker member to move into the next operating mode without additional external forces. After the rocker member has been moved into an operating mode, it will stay in that operation mode unless its operation mode is further toggled.

Fig. 1A shows a typical actuation force-displacement diagram of a conventional rocker switch. As shown in the Figure, the maximum actuation force occurs when an actuation force is initially applied to overcome inertia of the spring biased rocker member of the rocker switch. This maximum actuation force is required to bring about initial movements of the rocker member about its pivotal or rocker axis so that the rocker member will move pivotally from a neutral position to a toggling position at which the operating modes of the rocker switch will be changed. The subsequent follow-on force which is required to bring the rocker member to the toggling position, or to complete the operation mode change, gradually decreases and becomes negligible when a critical threshold position has reached. Once this critical threshold position is reached, the internal spring bias of the rocker member will take over to complete toggling and no additional external force is required to cause the rocker member to completely change its operating positions. In the force diagram shown, force F_N represents the characteristic minimum vertical actuation force required to move the push-button downwards at distance D.

Electrical switches comprising push-button actuated rocker switching mechanism are known. Such switches typically comprise a push-button, a rocker switching mechanism and drive conversion means for interconnecting the push-button and the rocker member of the rocker switching mechanism. The drive conversion means is also provided for converting linear motion of the push-button into a rotational or pivotal motion for driving the rocker member into different operation positions. For a conventional push button rocker switch, the resistive force which a user will feel or encounter in the course of changing the operating modes of the switch is generally as shown in Fig. 10A. It is apparent from Fig. 10A that there is a steep or stepped increase of resistive force when the rocker is initially encountered.

In the force diagram of Fig. 10A, the entire displacement range of the push-button of the electrical switch of Fig. 9 is represented by 0 to d_4 . The positions 0 and d_4 correspond respectively to the zero and the maximum displacements of the push-button. The positions are sometimes respectively referred to as the rest and fully depressed positions. As is apparent

from this force diagram, when a user pushes the push button **210** towards the rocker member so as to cause change of operation modes, the user can feel a gradually increasing resistance until the push-button has displaced for a pre-determined distance d_1 . At this position d_1 , the drive conversion means encounters the rocker member and the resistive inertia of the rocker
5 has to be overcome if the rocker member is to be moved into the next stable operating position. This inertia overcoming force is an abrupt step, as shown at d_2 of Fig. 10A. As a result, a user will experience an abrupt or stepped increase in resistive force. The resistive force will gradually decrease between displacement positions d_2 and d_3 and will resume a positive slope (i.e., incremental) at the displacement point d_3 when the critical threshold position has been
10 passed. This is because, at d_3 , the biasing spring for returning the push button to its neutral position takes over and will appear as the residual resistive force. This biasing spring force will appear until the push-button has completed its entire displacement range at position d_4 .

In the description below, common numerals will be used to refer to parts which are common or equivalent unless the context otherwise requires.

15 In Figs. 2 to 9, a first preferred embodiment of a push button rocker switch **10** is shown. The electrical switch **10** comprises a rocker switching mechanism **100**, a push-button means comprising a button interfacing cap **200**, a resilient urging assembly **300**, drive conversion member **400** and a main housing **500**. Although the various parts in the switch of this example are accommodated in the main housing **500** for convenient mounting and insulation, it will be
20 appreciated that the switch may be mounted as part of an apparatus or equipment.

The rocker switch **100** can be of a conventional design, for example, a rocker switch of Fig.1. Of course, other appropriate or new rocker switches from time to time available can be utilised without loss of generality. Similar to a rocker switch of Fig. 1, the rocker switch **100** comprises a rocker member **110** and a contact actuated rocker switching assembly. The
25 contact actuated rocker switching assembly, or rocker switching mechanism in short, comprises an electrical contact member **120** which is operable to facilitate the making or breaking of a plurality of alternative electrical circuit connections. The specific connections are typically dependent on the instantaneous stable positions of the rocker member **110**. For example, two or three alternative circuit connections can be provided by a single rocker switching mechanism.

30 A spring assembly is typically provided in a rocker switch. This spring assembly is provided for urging the electrical contact member of the rocker member to remain in the stable operation position once it has been moved into that position. The spring assembly also serves a dual function of moving the contact member into the next operating position once the rocker member has been moved to the critical threshold position. Typically, the spring assembly comprises a
35 coil spring **140** which is fitted inside a hollow body of the rocker member with its axis substantially normal to the rocker axis **130**. Of course, other resilient urging means can serve the same or equivalent purposes.

The rocker member **110** comprises a rocker body **111** with a pair of rocker arms **112**. The rocker arms **112** are symmetrically disposed about the neutral pivotal axis of the rocker body. The lateral end of each of the rocker arms protrudes upwardly from the rocker body and extends towards the push-button.

5 The push-button means comprises a push button member and a button interfacing cap **200**. The button interfacing cap **200** comprises a main body with a contact surface **210**. The upper-side and lower side of the contact surface **210** are respectively for interacting with the push button member and for transmitting downward movements of the push button member through to the rocker member. The main body of the button interfacing cap **200** provides a distributed
10 contact surface for interacting with the resilient urging assembly **300** as well as for providing a pivotal support to the pivoting motion of the drive conversion member to be explained below. It will be noted that the main body of the button interfacing cap **200** and the main housing **500** of the switch together forms a co-operative guiding means so that the push-button can slide in and out of the main housing along a predetermined direction, that is, linearly towards and away from
15 the rocker member during mode changing operations.

The resilient urging means of this embodiment comprises a resilient urging assembly **300** which is disposed between the button interfacing cap **200** and the rocker member **110**. The resilient urging assembly comprises first resilient means **320** and second resilient means **330**. The first resilient means **320** is for providing a resilient return-urging force so that the push
20 button or the button interfacing cap will be returned from a depressed position to the initial spring neutral or zero displacement position d_0 after it has been released. This first resilient urging means also helps to mitigate the abruptness or ruggedness to be felt by a user in the course of actuating a push button rocker switch due to the actuation force characteristics of a rocker switch by introducing an incremental resistive force against the motion of the
25 push button while the push button is travelling towards but before encountering the rocker member. By gradually increasing the resistive force while the push button is moving towards the rocker member, the height of the resistive force step, that is, the abrupt step at d_1 , will be reduced and the user will experience a better "feel".

Thus, the first resilient urging means of this resilient urging assembly **300** serves a plurality
30 of purposes in this invention. Firstly, it provides an incremental resistive force, e.g., a variable resistive force, against the movement of the push-button which will cause change of operation modes. Specifically, this resistive force is present so that a user can feel the resistive force substantially along the entire displacement range of the push-button. Secondly, it provides a resilient spring bias for restoring the push-button to its zero displacement position when the
35 push-button is released. Thirdly, it provides an additional incremental resistive force to narrow the step gap of the rocker actuation force to be explained below. Examples of suitable resilient urging assembly are shown in Figs. 2A, 2B, 2C and 2D. Of course, other suitable forms of resilient urging assembly can be adopted without loss of generality. Also, while an assembly is

described in the specification, it will be appreciated that the term is used only for convenience. Naturally, the resilient urging assembly can be formed as a single unit or as a distributed means.

The second resilient urging means **330** serves to provide additional resilient resistive force against the push button when the push button is moving towards but before encountering the rocker member. This resistive force is incremental so that the step-height of the additional or differential actuation force required to overcome inertia of the rocker member is reduced.

To benefit from the additional incremental resistive force while still maintaining a compact design, a drive conversion means comprising a drive conversion member **400** for converting a linear motion of the push button to a rotary or pivotal drive motion is disposed between the button interfacing cap **200** and the rocker member **100**.

As shown in Fig. 2A, an example of a resilient urging assembly **300** comprises a platform member **310** and a pair of spring members **320**. The pair of spring members is disposed on the lateral sides underneath the platform member. Each of the spring members is a coil spring with the spring axis substantially parallel to the direction of the actuating force so that when the push button is depressed, the coil springs are compressed. When the push button is released, the stored energy in the spring members will provide a returning spring force to return the push button to the spring zero position. Of course, the spring members can be adapted so that they are stretched, instead of compressed, during push button actuation. Fig. 2B shows a variation of a resilient urging assembly **300A** with a centrally disposed single coil spring to replace the laterally displaced spring members of Fig. 2A. The coil spring may have a rectangular cross section instead of a circular cross section as depicted. Fig. 2C shows another variation of an exemplary resilient urging assembly **300B** with the spring members of Fig. 2A replaced by a pair of resilient legs which are symmetrical about the center of the metallic board and are divergent from the metallic board. Fig. 2D shows yet another exemplary resilient urging assembly comprising a platform member and a pair of resilient legs. In this design, the platform member and the pair of resilient legs are separable which facilitate possible individual tuning of the spring forces of the two parts for enhanced flexibility.

To provide an additional incremental resistive force against the push button in its course to change operation modes of the rocker switch so as to narrow the aforementioned resistive force step or differential, the resilient urging assembly **300** provides an additional spring means. This additional spring means is adapted to perform the requirements of the secondary resilient counteracting means mentioned above and will be referred to as secondary spring means herein for convenience. In this example, the platform member **310** is formed from a resilient material, such as a steel plate, and is made as a thin metallic board. The secondary spring means comprises a pair of spring arms **330** which are integrally formed with the metallic board and overhanging the metallic board. As can be seen from Fig. 2A, a spring arm **330** joins the metallic board at one of its longitudinal ends and extends towards the other longitudinal end of the metallic board. The free ends of the pair of spring arms are opposite and approaching each

other. In other words, the pair of spring arms are substantially collinear and parallel to the longitudinal axis of the metallic board.

The drive conversion means comprises a pendulum-like drive conversion member (or a pendulum member in short) **400** which is adapted for converting the linear motions of the push button into a rotary or pivotal motion so as to facilitate change of operation modes of the rocker switch. The pendulum-like drive conversion member **400** comprises a main body **410** which is pivotally mounted on the housing of the button interfacing cap **200**. A pair of slightly chamfered shoulder portions **420** is formed at the distal end of the main body **410** which is distal from the pivotal axis. The shoulder portions **420** are chamfered so that the distal ends of the main body slant away from the centerline of the main body such that the outside edges of the main body are shorter than the middle portion of the main body **410**. The shoulder portions are laterally displaced from the centerline of the main body and are always substantially symmetrically about the pivotal axis. This lateral symmetry facilitates a symmetrical operation of the rocker switches of the type as shown in Fig. 1 with two operation modes.

The operation of the push button operated rocker switch of Fig. 2 will now be explained with reference to Figs. 3 to 9. As shown in Figs. 3 and 3A, the push button is initially at its zero displacement position or the spring neutral position d_0 . When an actuation force F is applied, a reactive force F_2 due to the primary spring means, that is, the spring members **320**, will be encountered. In Figs. 4 and 4A, the push button has moved downwards for a predetermined distance and is at a displacement d_1 . At this displacement, the front edge on the right shoulder of the pendulum-like drive conversion member **400** will begin to move into contact with a corresponding protruding head of the rocker member. Also, the rear side of the right shoulder portion of the drive conversion member is also touching the underside of the spring arm **330**.

Due to the outwardly slanting slope of the chamfered shoulder portion, the drive conversion member will operate like a cam on the protruding head and begin to rotate anti-clockwisely about its pivotal axis when the push button is depressed further. Since the rear side of the shoulder portion of the drive conversion means is already touching the spring arm at displacement position d_1 , when the push button is depressed further from displacement d_1 to d_2 , the additional rotation of the conversion drive member will tend to move the spring member away from the plane of the metallic board. As the spring member is hinged to the metallic board, the free end of the spring arm **330** will pivot about the junction between the spring arm **330** and the metallic board.

As shown in Figs. 5 and 5A, when the push button is now at the displacement position d_2 , the spring arm **330** has pivoted clock-wisely through an angle α about the pivotal junction. As the spring arm **330** is integrally formed with the resilient metallic board, a resilient urging force as represented by a force arrow F_1 will act on the spring arm when the spring arm is at displacement position d_2 . At this displacement, the total resistive or counteracting force F which

is to be experienced by a user will be a resultant of the vertical components of the forces F_1 & F_2 . The displacement position d_2 in this example is selected to be the position at which the rocker member is just about to be subject to a toggling force. The angular position α is also set to be the maximum angle through which the spring arm can pivot. This maximum angular position is set by a limiting means disposed on the main housing of the push button, for example, in the form of a ceiling which prevents further advancement of the spring member **330**. In summary, the source of the actuation and resistive forces are as follows:-

- (a) F , the actuation force applied by a user on the push-button,
- (b) F_2 , the upward resistive force due to the spring member **320** of the resilient urging assembly,
- (c) F_1 , the force acting on the spring arm when the spring arm has rotated for an angle α .

In Fig. 6, the push button has been moved further downwards for an additional displacement δ and is now at a displacement $d_2 + \delta$, where δ is of an infinitely small value. At this displacement position, the push button has been depressed with an adequate force applied to overcome the initial turning inertia of the rocker member so that the rocker member will begin to pivot about its axis. The resistive force represented by the force arrow F_3 , which is at an angle γ to the vertical, is the additional force acting on the rear edge of the shoulder portion of drive conversion member by the push button housing which provides the additional threshold force to overcome the inertia of the rocker member. At this displacement, the total resistive or counteracting force F which is to be experienced by a user will be a resultant of the vertical components of the forces F_1 , F_2 & F_3 .

In Fig. 7, the push button is shown at displacement d_3 . At this displacement, the rocker member has reached the critical threshold displacement so that it will complete the mode changing toggling movement automatically without requiring additional external force. The push button actuation mechanism is configured so that the push-button can move further downwards from the displacement position d_3 until the bottom dead end d_4 . An additional free displacement range (d_3 to d_4 in the present example) is provided, for example, to accommodate the variation in the critical threshold displacement of the rocker member or to cater for tolerance in the rocker member characteristic due to effluxion of time. At this stage, the resilient force due to the spring arm **330** will act to return the drive conversion member **400** back to its initial zero displacement position.

In Fig. 8, the push button is shown at displacement d_4 . At this displacement, the rocker member **110** has complete operation mode change and the spring arm **330** will continue to drive the drive conversion member clock-wisely back to the initial position.

In Fig. 9, the push button has been returned to the zero displacement position d_0 by the spring members **330** after the push button is released. At this displacement position, the rocker member has complete operation mode change and the spring arm **330** has returned the drive conversion member back to the initial starting position.

5 The overall resistive force F felt by a user in the above course of operation mode change is shown in Fig. 10D. The force diagram of Fig. 10D is a resultant of 3 forces, namely, the force F_2 due to the spring members **320** which increases with displacement between d_0 to d_4 as shown in Fig. 10B, the vertical component of the counteractive force F_1 acting on the spring arms **330** which is incremental between d_1 to d_2 and which remains constant thereafter due to the limiting
10 device and the vertical component of F_3 , the additional forcing acting by the rear edge of the shoulder portion of the drive conversion member on the push-button housing. It has been assumed for the sake of simplicity that the force acting on the hinge is negligible. It will be appreciated that the height of the resistive step d_1 as shown in Fig. 10A has been significantly reduced.

15 Referring to Figs. 11 to 16, there is shown a second preferred embodiment of an electrical switch of the present invention in the form of a switch-able socket outlet comprising a push-button actuated rocker switching mechanism. In the description below, because the main operating parts are generally similar, parts which are similar, identical or equivalent to that of the first preferred embodiment above will be identified with the same numeral for brevity and
20 convenience where appropriate unless the context otherwise requires.

Similar to the switch **10** of the first preferred embodiment, the electrical switch **20** comprises a rocker switching mechanism **100**, a push-button comprising a button interfacing cap **200**, resilient urging assembly **300**, drive conversion means **400** and a main housing **500**. Similar to the first preferred embodiment, the resilient urging assembly comprises primary and
25 secondary spring urging means. The primary resilient urging means provides incremental resistive force commensurate with the amount of downward movement of the push button and is exemplified by a pair of spring members **320**. The second spring urging means is exemplified by a pair of overhanging spring arm members **330** with their respective fixed ends disposed near the ends of the lateral wings of the exemplary spring-like metallic board **310** with the free
30 ends directing towards each other.

The switch-able socket also comprises a movable contact member and a fixed contact member the connection of which are toggled by the rocker switching mechanism. Figs. 11-16 show a sequence of operations by which the movable rocker member **110** is moved from a first switching position to a second switching position by the push button. The sequence of
35 operations is substantially the same as that illustrated by Figs. 2-9 and is not repeated here.

While the present invention has been explained by reference to the examples or preferred embodiments described above, it will be appreciated that those are examples to assist understanding of the present invention and are not meant to be restrictive. The scope of this

invention should be determined and/or inferred from the preferred embodiments described above and with reference to the Figures where appropriate or when the context requires. In particular, variations or modifications which are obvious or trivial to persons skilled in the art, as well as improvements made thereon, should be considered as falling within the scope and
5 boundary of the present invention.

Furthermore, while the present invention has been explained by reference to a stand-alone switch and a wall-socket type switch, it should be appreciated that the invention can apply, whether with or without modification, to other types of switches without loss of generality. Also, the reference to dimensions and displacement is only for comparison and is not meant to
10 impose any restriction.

CLAIMS

1. An electrical switch comprising:

- a push-button,
- a rocker switching mechanism having a rocker member,

5 • resilient urging means, and

- drive conversion means for converting motion of the push button into motion suitable for changing the operation modes of the rocker switching mechanism,

wherein, the drive conversion means operates as an interface between the push-
10 button and the rocker member whereby switching modes of the rocker switching mechanism can be changed by the drive conversion means in response to motion of the push button, the resilient urging means is disposed between the push-button and the rocker switching mechanism and is adapted for providing a resilient resistive force against motion of the push button towards the rocker member, for
15 returning the push button towards a spring neutral or zero displacement position and for providing an additional resilient resistive force to the drive conversion means whereby differential actuation force required to overcome inertia of the rocker member in order to bring the rocker member into a switching motion is reduced; and

20 wherein the resilient urging means comprises primary and secondary resilient urging means, the primary resilient urging means is adapted for returning the push button towards its spring neutral or zero displacement position and the secondary resilient urging means is adapted for returning the drive conversion means towards a pivotally neutral position which is intermediate positions at which the switching
25 modes of the rocker switching mechanism will be changed by the drive conversion means.

2. An electrical switch according to Claim 1, wherein the resilient resistive force exerted by the resilient urging means on the push button is incremental when the push-button is moving from the zero displacement position towards the rocker member, the rate of increase of the resilient resistive force is higher when the push
5 button is nearer the rocker member and is lower when the push button is nearer the zero displacement position.
3. An electrical switch according to Claims 1 or 2, wherein the additional resilient resistive force of the resilient urging means operates to return the drive conversion means towards a neutral position which is away from the position at
10 which the switching mode of the rocker switching mechanism will toggle.
4. An electrical switch according to Claim 3, wherein the additional resilient resistive force is positive when the push button is moving towards the rocker member and before the drive conversion means encounters the rocker member, the resilient resistive force is negative after the drive conversion means has
15 encountered the rocker member and after inertia of the rocker member has been overcome.
5. An electrical switch according to Claim 4, wherein the resilient resistive force is negative and decremental after inertia of the rocker member has been overcome but before the rocker member is driven into a position at which switching mode
20 changing will occur without additional external actuation force.
6. An electrical switch according to any of the preceding Claims, wherein the drive conversion means comprises a pendulum member which is pivotally movable about its pivotal axis, the pendulum member comprises a drive head which is pivotally movable about the pivotal axis between positions at which the switching
25 modes of the rocker switching mechanism change.
7. An electrical switch according to Claim 6, wherein the pivotal axis of the pendulum member is substantially orthogonal to the direction of movements of the push button.

8. An electrical switch according to Claim 1, wherein the secondary resilient urging means begin to operate to provide additional resilient resistive force to the push button after the push-button has moved for a predetermine displacement from a neutral position towards a toggling position at which the switching mode of the rocker switching mechanism will toggle but before the drive conversion means encounters the rocker member, the toggling position is one at which no further external force is required to change the operation modes of the rocker switching mechanism.
9. An electrical switch according to any of the preceding Claims, wherein the urging resistance against motion of the push-button towards the rocker member is incremental after no additional force is required to change the operation modes of said rocker switching mechanism.
10. An electrical switch according to Claim 1, wherein the resilient urging means comprises first and second spring urging means, the first spring urging means operates to return the push button to its zero displacement position and the second spring urging means is adapted for exerting urging resistance against the push-button after the first spring urging means has already acted against the push-button for a pre-determined displacement towards but before reaching a position at which the operating modes of the rocker switching mechanism are changed.
11. An electrical switch according to Claim 10, wherein the first and second spring urging means are adapted for providing incremental resistance against said push-button when the push-button is moving towards a position at which the operating mode of the rocker switching mechanism are changed and before resistance of the rocker switching mechanism is encountered.

12. An electrical switch according to Claim 10, wherein the resistive force of the first spring urging means is reactive and substantially parallel to direction of the applied actuating force of the push-button, the resistive force of the second spring urging means is at an acute angle to the applied actuating force.

13. An electrical switch according to Claim 12, wherein the first spring urging means comprises a pair of resiliently deformable legs which are substantially symmetrically disposed about the axis of the push-button and which provide a resistive force against the linear actuation motion of the push-button.

14. An electrical switch according to Claim 13, wherein the second spring urging means is resiliently deformed away from the rocker member of the rocker switching mechanism after the drive conversion means has encountered the rocker member and the resilient deformation of the second spring urging means operates to resist pivotal movement of the drive conversion means after the push-button has moved for a pre-determined displacement towards the rocker member.

15. An electrical switch according to any of the preceding Claims, wherein the drive conversion means comprises a pendulum-like driving member having a pivoted end and a swivable end, the swivable end of the driving member is pivotally movable relative to the pivoted end, the swivable end of the driving member and the rocker member of the rocker switching mechanism are co-operatively configured so that when the pivoted end of the driving member is moved towards the rocker member in response to actuation motion of the push-button, the swivable end will be rotated towards a actuation position, whereby said the rocker member will be driven towards a position at which the operation modes of the rocker switching mechanism will be changed.

16. An electrical switch according to Claim 15, wherein the rocker member is pivotally movable about a rocker axis, the rocker member comprise a pair or

protruding arms which are symmetrical about the rocker axis, the pendulum member comprises a pair of driving heads which are symmetrical about the pivoted end, the driving heads of the drive conversion member and the protruding arms of the rocker member are arranged so that the protruding arms of the rocker member are alternatively driven by the corresponding driving heads for toggling the operating modes of the rocker switching mechanism.