Aug. 10, 1965 J. W. LUX 3,200,224

QUICK-ACTING PERIODIC SWITCH

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Fig. 2.

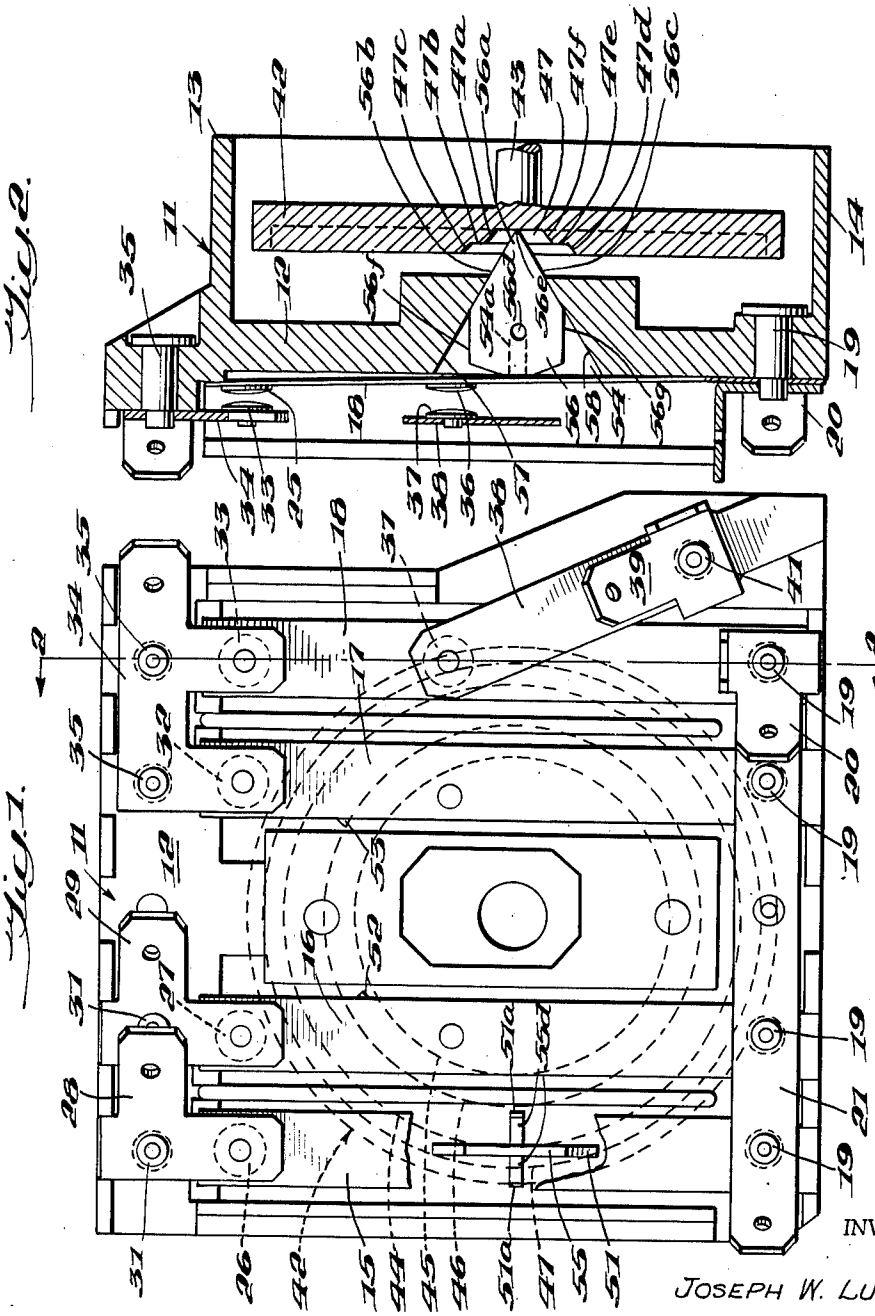

Fig. 1.

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Fig. 3.

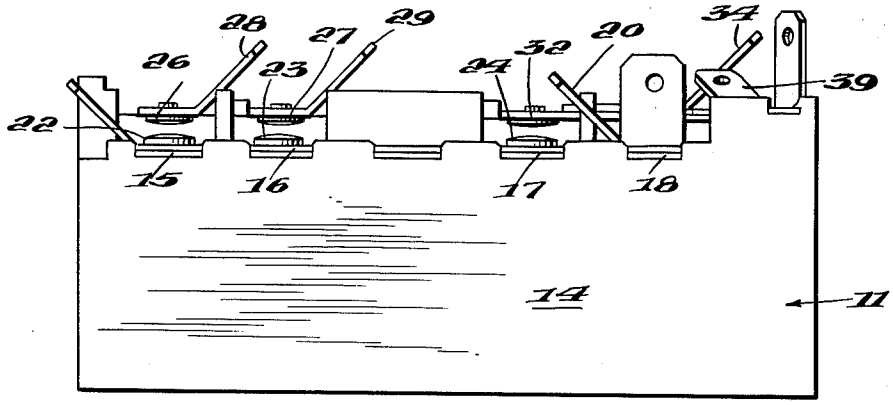


Fig. 5.

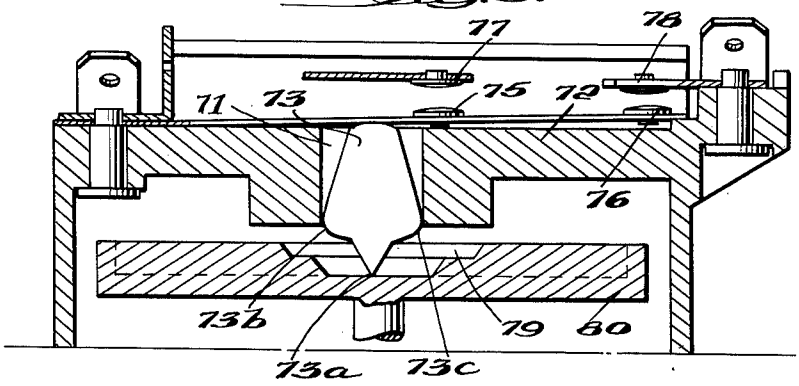
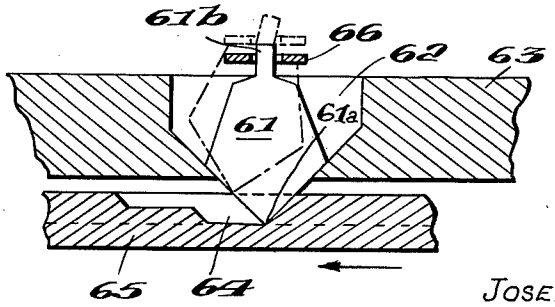


Fig. 4.



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QUICK-ACTING PERIODIC SWITCH

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10 Claims. (Cl. 200—153)

This invention relates generally to a periodic switch of the cam-operated type provided with novel cam follower means affording a mechanical advantage to achieve rapid make or break switch actuation.

In the past, it has been difficult in the periodic switch art to obtain rapid, accurately-timed switch actuation, especially when the switch is operated by cam means driven at relatively low speeds. Furthermore, the known cam-driven periodic switches have a tendency toward jamming when the direction of rotation of the cam is reversed. Periodic switches of the multiple contact type disclosed in the prior art have proven to be large in size, complex and expensive to manufacture, and unreliable in operation. The present invention was developed to provide an improved quick-acting cam-operated multi-contact switch that avoids the above and other drawbacks of the known periodic switching devices.

An object of the present invention is to provide a quick-acting periodic switch having actuating means of the cam and follower type affording a mechanical advantage to achieve rapid movement of a spring-biased follower from a displaced position to a normal position, whereby the states of engagement of a pair of switch contacts operated by the follower are reversed.

A more specific object of the invention is to provide switch actuating means including a spring-biased cam follower that is both pivotally and longitudinally shiftable by a cam from a first position and orientation causing a first state of engagement between a pair of switch contacts to a second position and orientation longitudinally and angularly displaced, from said first position, said follower in said second position causing the opposite state of engagement between the switch contacts.

A further object of the invention is to provide a periodic multiple contact switch of compact, simple inexpensive construction having a single disk-type cam provided with a plurality of concentrically arranged narrow tracks for pivotally and longitudinally shifting a plurality of spring-biased followers to positions in which mechanical advantage may be utilized for achieving rapid make or break multiple contact actuation.

The present invention is characterized by the use of a cam follower that is mounted in an opening in a portion of the switch casing for both pivotal and longitudinal movement by a cam. The follower is spring-biased toward a first position in which the follower axis is parallel with the opening axis. A pair of switch contacts operable by the follower has a first state of engagement when the follower is in this first position. A cam is operable to pivot and longitudinally displace the follower against the biasing means to a second position and orientation in which the switch contacts have the opposite state of engagement. When the follower is in this second position, its axis is arranged at an acute angle to the opening axis whereby a mechanical advantage is afforded for rapidly returning the follower to its normal position. According to the invention, the follower is pivotally movable in the opening about a pivot axis that is shiftable in a direction generally parallel with the opening axis. In one embodiment of the invention, the pivot axis is defined by a positive pivotal connection between the follower and the switch casing. In another embodiment of the invention, the pivot axis is defined by a positive pivotal

connection between the follower and a resilient movable contact carrier that serves as the follower biasing means.

Other objects and advantages of the invention will become apparent from a study of the following specification when considered in conjunction with the accompanying drawing, in which;

FIG. 1 is a plan view of the preferred embodiment of the cam-operated multiple contact switch;

FIG. 2 is a sectional view taken along line 2—2 of FIG. 1;

FIG. 3 is an elevational side view of the switch of FIG. 1; and

FIGS. 4 and 5 are detailed sectional views of two modifications of the cam-follower embodiment of FIGS. 1–3.

Referring more particularly to FIGS. 1–3, the multiple contact switch includes a molded plastic frame **11** having a horizontal plate **12**, a pair of side walls **13** and **14**, and a pair of end walls, not shown. A plurality of resilient carriers **15–18** formed of an electrically conductive material, such as copper, are each secured at one end to the upper surface of plate **12** by rivets **19** and are electrically connected with terminal **20** by jumper **21**. Movable switch contacts **22–25** are secured to the free ends of carriers **15–18**, respectively. Stationary switch contacts **26** and **27** are secured to single side terminals **28** and **29**, respectively, that are riveted to the frame by rivets **31**, and stationary switch contacts **32** and **33** are secured to double terminal and jumper **34** that is riveted to the frame by rivets **35**. Stationary contacts **26**, **27**, **32** and **33** are arranged for make and break electrical contact with movable contacts **22–25**, respectively. Movable contact **36** is secured to carrier **18** intermediate its ends for make and break contact with stationary contact **37** that is secured to carrier **38**. Carrier **38**, which is formed of an electrically conductive material such as copper, and its asociated terminal **39** are riveted to frame **11** by rivet **41**.

The make and break action of the stationary and movable switch contacts is controlled in a periodic manner by cam disk **42** that is rotatably mounted below and parallel with plate **12** by means of cam shaft **43**. Shaft **43** is driven by motor means, not shown. Cam disk **42** is provided with circular cam tracks **44–47** concentrically arranged relative to cam shaft **43**. Plate **12** contains through openings **51–54** beneath carriers **15–18**, respectively. Mounted for pivotal and reciprocatory movement in openings **51–54** (each of which has a rectangular transverse cross-section) are four cam followers that are controlled by cam tracks **44–47**, respectively, for operating carriers **15–18**, respectively. Follower **55** that engages track **44** and controls the operation of carrier **15** is shown in FIG. 1, and follower **56** that engages track **47** and controls the operation of carrier **18** is shown in FIG. 2. The remaining two followers, not shown, are similar in structure and operate in the same manner as followers **55** and **56**. The four followers are biased into engagement with their respective cam tracks by the resilient carriers **15–18**, respectively.

Referring to FIG. 2, it will be seen that the two opposed end walls **57** and **58** of opening **54** converge toward the lower side of plate **12**. Follower **56** has a lower portion **56*a*** defined by convergent walls **56*b*** and **56*c*** that are in parallel contiguous engagement with opening walls **57** and **58**, respectively, when follower **56** is in the illustrated position. It is to be noted that when follower **56** is maintained in the illustrated position by the biasing action of carrier **18**, the longitudinal axis of the follower is colinear with the axis of the opening and the pointed extremity **56*e*** of the follower extends into cam track **47**. Opposed pivot pins **56*d*** carried by follower **56** extend

laterally outwardly therefrom into slots 54*a* provided in opposed side walls of opening 54, said slots being parallel with the axis of opening 54. (The corresponding projection of pivot pins 55*d* of follower 55 into slots 51*a* of opening 51 is shown in detail in FIG. 1.) These slots permit pivotal movement of the followers about pivot axes that are shiftable in a direction parallel with the axes of the respective plate openings. All four followers are similar in structure and operation to the follower illustrated in FIG. 2.

Operation

Assuming that cam disk 42 is rotated in the clockwise direction, follower 56 is displaced to the left in FIG. 2 and is pivoted in the clockwise direction about pivot rod 56*d* when the pointed extremity 56*e* of the follower is engaged by inclined surface 47*a* of track 47. Movement of follower 56 to the left causes deformation of carrier 18 in the counterclockwise direction (FIG. 2) and when follower extremity 56*e* engages flat surface 47*b* of track 47, stationary and movable switch contacts 33 and 25 are in electrical engagement. Follower 56 is maintained in a pivotal orientation in which its longitudinal axis is slightly inclined to the opening axis. Upon further roation of cam 42, follower extremity 56*e* is engaged by cam track inclined surface 47*c*, and the follower is further shifted to the left and is further pivoted in the clockwise direction about pivot rods 56*d*. The central portion of carrier 18 is deformed by this movement of the follower to effect electrical contact betwen movable and stationary switch contacts 36 and 37. When the follower extremity 56*e* is in sliding engagement with the upper surface of cam 42, follower 56 is maintained in a maximum left hand position and in a pivoted orientation in which the longitudinal follower axis is at an acute angle relative to the opening axis. The upper side wall portions 56*f* and 56*g* of follower 56 are cut away to permit the above-described pivotal movement of the follower in opening 54.

Assume now that cam 42 has substantially completed one revolution. When follower extremity 56*e* engages the upper end of inclined surface 47*d* of track 47, follower 56, owing to the biasing action afforded by carrier 18 and the mechanical advantage resulting from the angular orientation of the follower, shifts quickly to the right as extremity 56*e* slides down surface 47*d*, and follower 56 pivots in the counterclockwise direction about pivot rods 56*d* through a small angle. The electrical contact between contacts 36 and 37 is quickly broken. When extremity 56*e* engages track surface 47*e*, follower 56 is maintained in a position that is shifted to the left from the illustrated position causing electrical contact between contacts 25 and 33, and with an orientation in which its longitudinal axis is displaced through a small acute angle in the clockwise direction relative to the axis of opening 54. Upon further rotary movement of cam 42, extremity 56*e* engages track surface 47*f*. Owing to the biasing action of carrier 18, follower 56 is quickly shifted to the right as extremity 56*e* slides along surface 47*f* and is pivoted in the counterclockwise direction about pivot rods 56*d*, whereupon the follower is returned to its illustrated position. During this movement of the follower, electrical contact betwen contacts 33 and 25 is quickly broken. It is apparent from the above description that the quick-break action of the contacts is a result of the fact that when the follower is in a position (shifted to the left from the illustrated position) maintaining the contacts in engagement, the axis of the spring-biased follower is at a small acute angle to the axis of the opening. Consequently, a mechanical advantage is afforded for quick return of the follower to the illustrated position regardless of the speed of rotation of the cam. It is apparent from FIG. 2 that owing to the inclination of cam track surfaces 47*a*, 47*c*, 47*d* and 47*f*, cam 42 may be rotated in either direction to effect efficient switch operation without jamming of the follower. While the switch has been disclosed as having "quick-break" opreaiton, it is obvious

that "quick-make" operation might be achieved equally as well by arranging the stationary switch contacts intermediate the carriers and the plate, and by arranging the movable contacts on the lower surfaces of the carriers.

With the above arrangement, it is apparent that the longitudinal shifting of the follower caused by its rotation accomplishes the closing and opening of the switch contacts, and that the particular structure of the follower permits its rotation in the actuated position without changing the position of the movable contcat carrier.

Since the present invention permits the use of narrow followers in combination with a relatively small cam having narrow, closely-spaced tracks, the advantage is afforded that a compact multiple switch may be achieved having extremely small overall dimensions. Furthermore, since a certain latitude is permitted in the location and operation of the followers, the switch may be designed to provide an infinite number of accurately-controlled switching relationships between each cooperating pair of electrical contacts. The followers will all operate on cams with vertical rises and falls, thus resulting in greater accuracy and simplicity in cam manufacture. Assembly of the followers in their respective plate openings may be achieved in a simple non-critical manner, and no mechanical joining of the parts is required.

Referring now to the cam follower embodiment of FIG. 4, follower 61 is mounted in opening 62 in plate 63 and is provided at its lower end with a pointed extremity 61*a* that extends through the opening into cam track 64 of cam 65. The cam follower is characterized by the provision of a pivoting projection 61*b* at its upper end that extends through an opening in movable contact carrier 66. As cam 65 moves to the left relative to plate 63, follower 61 is moved upwardly in FIG. 4 and is pivoted in the clockwise direction about the pivot axis defined by the cooperation between projection 61*b* and the opening in carrier 66. The pivot axis, of course, is displaced in a direction substantially normal to plate 63 as carrier 66 is deformed upwardly by the lifting action of the cam track on the follower. As shown by the phantom lines, when the follower is maintained in its maximum elevated position by the cam, the longitudinal axis of the follower is at an acute angle to the axis of opening 62. As a consequence of this angular orientation of the follower, the mechanical advantage quick-break operation described above with reference to the embodiment of FIGS. 1–3 is obtained.

In the follower embodiment of FIG. 5, the walls of rectangular opening 71 in plate 72 are parallel with the opening axis and the configuration of the follower 73 is such that the follower slides and pivots freely in the opening. Carrier 74, that carries movable contacts 75 and 76 for electrical engagement with stationary contacts 77 and 78, respectively, biases follower 73 downwardly to cause the pointed extremity 73*a* thereof into cam track 79 of cam 80. The sides of follower 73 are provided with rounded projecting portions 73*b* and 73*c* that cooperate with the associated wall surfaces of opening 71 to define pivot axes movable in a direction parallel with the opening axis. Thus, when extremity 73*a* is engaged by an inclined surface of the cam track, the folower is simultaneously raised relative to the plate and is pivoted about rounded portion 73*b* or 73*c* (depending on the direction of rotation of the cam) until one of the straight upper side surfaces of the follower comes into contiguous engagement with the associated straight wall surface of opening 71. The follower is thus maintained in an orientation in which the follower axis is inclined at an acute angle to the opening axis. As distinguished from the embodiments of FIGS. 1–4, no positive pivot means are provided for pivotally connecting the followers of FIG. 5 to either the plate or the carrier. The quick-break operation of the embodiment of FIG. 5 is identical to that described with reference to the embodiments of FIGS. 1–4.

Inasmuch as various modifications, changes and reversal of parts will be apparent to those skilled in the art, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A quick-acting switch, comprising

a support containing a plate with a through opening;

a cam on one side of said support adjacent said opening;

a cam follower arranged in said opening for pivotal movement relative to said plate;

means defining a pivot axis for said follower, said follower and said pivot axis being shiftable in a direction generally normal to the support;

a resilient carrier on the other side of said support biasing said follower into engagement with said cam, said cam being operable to place said follower alternately in a first position relative to said support in which the follower is oriented with its longitudinal axis normal to the support, and in a second position displaced from said first position in the direction of said carrier and with an orientation in which the follower axis is inclined at an acute angle to a plane normal to the support;

a movable contact secured to said carrier;

and a stationary contact connected with said support for opposite states of engagement with said movable contact when said follower is in said first and second positions, respectively.

2. The combination as defined in claim 1 wherein said stationary contact is arranged for electrical engagement with said movable contact when said follower is in said second position.

3. The combination as defined in claim 1 wherein said pivot axis means includes a positive pivotal connection between said follower and said support, said pivotal connection being displaceable in a direction generally normal to the support.

4. The combination as defined in claim 3 wherein said pivotal connection means comprises pivot pins extending laterally from opposite sides of said follower, the walls of said opening containing parallel opposed slots slidably receiving said pivot pins.

5. The combination as defined in claim 1 wherein said pivot axis means includes a pivotal connection between said follower and said carrier.

6. The combination as defined in claim 5 wherein said pivotal connection means comprises a pivot projection extending axially from one end of said follower adjacent said carrier, said carrier containing an opening receiving said pivot projection.

7. The combination as defined in claim 1 wherein said pivot axis means comprises said follower and said opening each having rectangular transverse cross-sections, and further wherein a pair of opposed walls of the opening converge in the direction of said cam, one end of said follower being provided with converging opposed side walls in seated engagement with said opening converging walls when said follower is in said first position.

8. The combination as defined in claim 1 wherein said pivot axis means comprises said opening and said follower having rectangular transverse cross-sections, and further wherein the walls of said opening are flat and parallel with the opening axis, said follower having rounded pivoting projections extending laterally from opposite sides thereof in engagement with the adjacent opening walls when said follower is in said first position.

9. The combination as defined in claim 1 wherein said cam comprises a cam disk rotatable in a plane parallel with said plate, said disk including a circular cam track below the support opening and concentric with the axis of rotation of said disk, said cam track having vertical rises and falls that are angularly arranged relative to the plane of rotation of said cam.

10. The combination as defined in claim 9 wherein said switch is of the multiple contact type, said cam disk including a plurality of concentrically arranged tracks, and said switch including a plurality of follower and carrier assemblies operable, respectively, by said cam tracks.

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