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H. L. PEEK ET AL

3,209,101

MOTOR AND SPRING OPERATED VACUUM SWITCH

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2 Sheets-Sheet 1

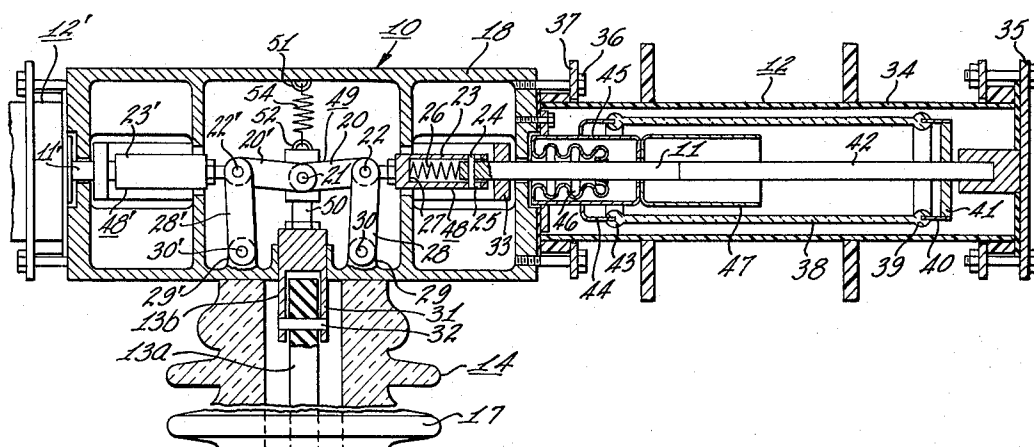


Fig. 1

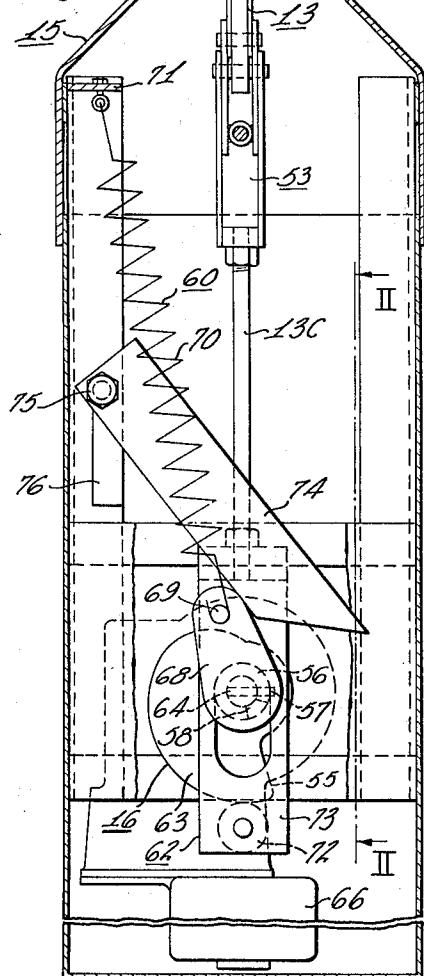
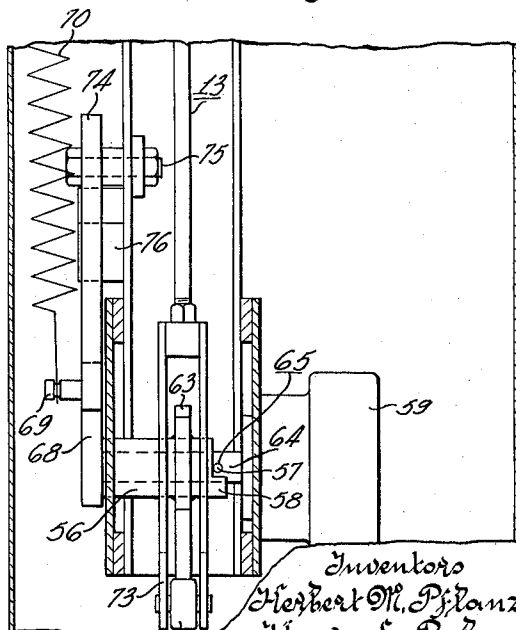


Fig. 2



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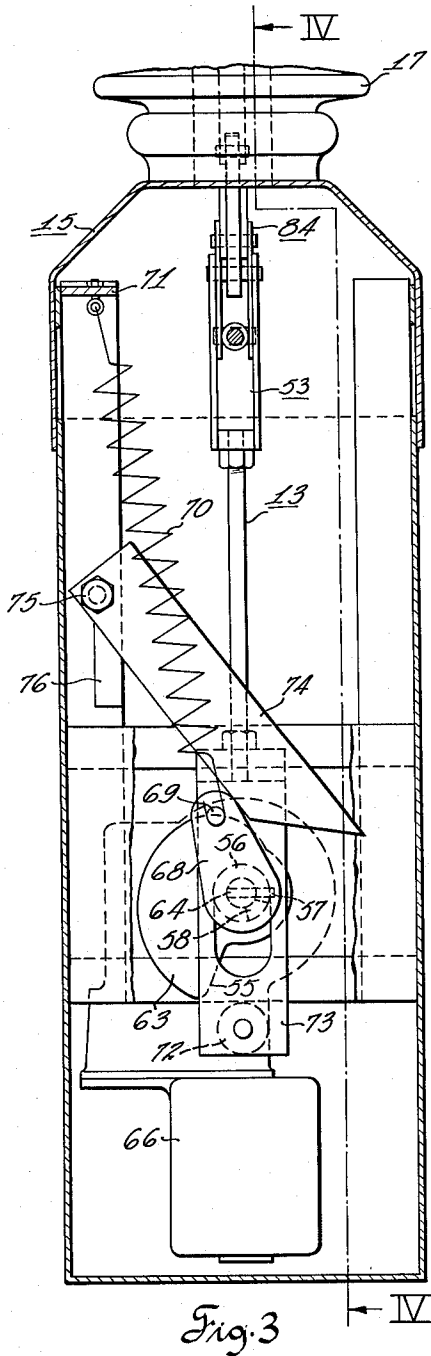


Fig. 3

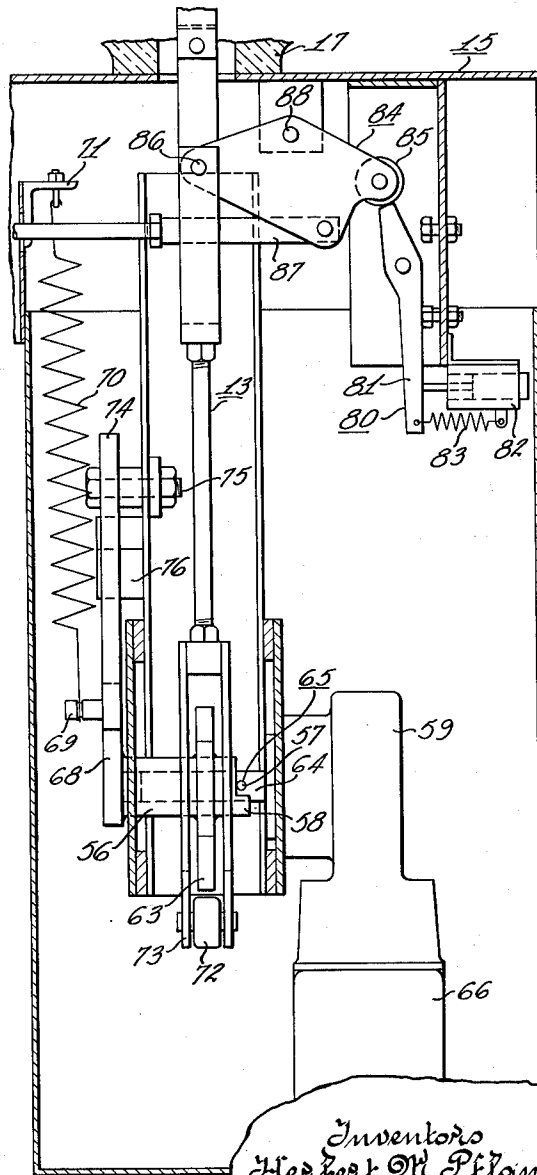


Fig. 4

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3,209,101 MOTOR AND SPRING OPERATED VACUUM SWITCH

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This invention relates to a means for actuating a switch or the like, and particularly to reciprocating means that utilize a cam movement for moving switch contacts to open and close a circuit.

Many circuit breaker installations use banks of switches that are operated together and, therefore, require a relatively great force, as from a motor, to operate the switch actuating mechanisms. When a motor is used, it is necessary to accurately control the stopping and starting of the motor and, often, to provide additional structure to effect quick tripping action to open or close the contacts.

In accordance with this invention, a contact actuating means utilizes a cam rotated by a motor to furnish movement to a cam follower for actuating contacts. In addition to the motor, a second means for rotating the cam independently of the motor is provided. This second means takes over the rotation of the cam after the motor has rotated the cam to a certain position. The cam is then rotated and accurately stopped at the desired position to close the contacts. The stopping of the motor is therefore not critical for this contact closing position.

To open the contacts the motor is rotated to place the cam follower against another portion of the cam. This portion is made to have a long equal radius so that no movement of the cam follower will result from a large degree of rotation of the cam. Therefore, the stopping of the motor is again not critical. The desirability of having a fast movement of opening is accomplished through a sharp change in cam configuration.

The actuating means can also be utilized with a quick trip means that operates without motor and cam rotation to effect the tripping. This can be made to operate from an external fault signal or other switching signal. Also, this actuating means, because of its relatively small size, is compatible with compact vacuum switches.

An object of this invention is to provide new and improved switch actuating mechanisms.

Another object of this invention is to provide switch actuating mechanisms for vacuum type switches with smaller, lighter, and less complicated mechanical structures.

Another object is to provide switch actuating mechanisms operated by the rotation of a motor that do not require accurate stopping and starting of the motor.

Another object is to provide switch actuating mechanisms that are reliable in operation and relatively inexpensive to manufacture.

Another object is to provide switch actuating mechanisms that are readily adaptable for operating vacuum switches or modules of vacuum switches.

Another object is to provide switch actuating mechanisms that are readily adaptable to provide quick tripping action to open or close contacts.

Another object is to provide a new and improved means for accurately and effectively positioning a cam to open and close contacts.

Other objects and advantages will be apparent from the following detailed description.

FIG. 1 is a partial cross sectional view of a vacuum switch and switch actuating mechanism embodying this invention;

FIG. 2 is a partial side view of the switch actuating

mechanism of FIG. 1 taken along lines II—II of FIG. 1;

FIG. 3 is a view of another embodiment of a switch actuating mechanism embodying this invention; and

FIG. 4 is a view of the switch actuating mechanism shown in FIG. 3 taken along lines IV—IV of FIG. 3.

FIG. 1 illustrates a circuit breaker or switch actuating mechanism 10 which comprises two vacuum switches 12 and 12', wherein like parts are provided with similar reference characters, mounted on a vertical column 14. Column 14 comprises a hollow insulator 17 and is mounted on a base or housing 15. A switch actuating means 16 is provided for moving movable contacts or members 11 and 11' to two positions; an open and closed position, with stationary contacts 42 and 42', respectively.

The contact actuating means comprises a cam, such as cam 63, having a circumferential surface circumscribed about an axis of rotation; a first driving means for rotating the cam; a second driving means for rotating the cam independently of the first driving means; and a connecting means 53 connected to movable contacts or members 11 and 11' and responsive to the position of the cam to move the movable contacts to the open and closed position.

The first driving means comprises a means for furnishing rotational power, such as a motor 66; a gear mechanism 59 for transferring the motor rotation; a drive shaft rotated by the gear mechanism output; a sleeve 56 encompassing a portion of the drive shaft and rotatable about the drive shaft; a free wheeling clutch 65 connected between the drive shaft and the sleeve for transferring the rotation of the drive shaft to the sleeve. The sleeve is rigidly attached to cam 63 so that rotation of the sleeve rotates the cam.

The second driving means comprises a biasing means 60, an inertia absorbing means and an arm 68 rigidly connected to sleeve 56. The biasing means comprises a device such as a tension spring 70 connected to arm 68 at a pin 69 located on arm 68 radially outwardly from the axis of rotation of sleeve 56. The other end of spring 56 is connected to housing 15 by a spring holder 71. The inertia absorbing means comprises a motion transfer pendulum 74 connected to housing 15 by a pendulum pivot 75. The pendulum is maintained in position by resting on a pendulum stop 76.

Connecting means 53 comprises a cam follower structure 62 having a cam roller holder 73 and a cam roller or follower 72, a linkage mechanism 49 connected to movable contacts 11 and 11' to move the contacts the desired distance in the desired direction, and shaft 13 connected between the cam follower structure and the linkage mechanism to transfer the reciprocal motion of the cam follower to the linkage mechanism.

One of the vacuum switches, switch 12, is shown in FIG. 1 in cross section. Switch 12' may be of the same construction to operate in the same manner as switch 12. The description will primarily describe switch 12 and is assumed to describe switch 12'.

Each switch may comprise a cylindrical casing 34 closed at one end by a cover 35 and secured to a housing 18 by suitable means such as bolts 36 and flange 37. Cover 35 may serve as an electrical contact for interconnecting the vacuum switches or connecting them to a load and electrical source.

As shown in FIG. 1, vacuum switch 12 also comprises a cylindrical envelope 38 which may be formed of a suitable vitreous material. One end of envelope 38 is provided with an annular rim 39 fixedly secured in vacuum tight connection to one end of a ring or flange 40. A metallic cap 41 is sealed throughout its edge to the other end of flange 40 in the manner shown. Cap 41 supports stationary contact 42 which is arranged to extend along the longitudinal axis of envelope 38.

The opposite end of envelope 38 is provided with an annular rim 43 which is fixedly secured in a vacuum tight connection to one end of a ring on flange 44. A tube or retainer 45 is sealed in a vacuum tight connection to flange 44 in the manner shown. A metallic cylindrically shaped bellows 46 is fixedly secured in a vacuum tight connection at one end to retainer 45. The other end of bellows 46 surrounds and is fixedly attached in a vacuum tight connection to movable contact 11 which is arranged through retainer 45 into envelope 38 in cooperating relationship with stationary contact 42.

The contacts 11 and 42 may be made of any suitable material, such as tungsten or copper. As shown in FIG. 1, contact 11 is arranged for longitudinal movement through a limited predetermined distance.

In order to control the arcing products emitted upon separation of the engaging surfaces of contacts 11 and 42, a cylindrical cup-shaped tube or shield 47 is provided around, and spaced from, contact 11. Shield 47 is arranged to extend beyond the adjacent ends of the contacts so as to surround at least a part of contact 42 when the contacts are in contact engaging position.

Upon actuation of movable contact 11 in axial contact engaging or contact disengaging direction, bellows 46 deflects allowing restricted longitudinal movement of contact 11. The required range of movement of contact 11 is very small. Since normal atmospheric pressure tends to expand the bellows into envelope 38, the atmospheric pressure may be utilized to hold the contacts together in normally closed position or to help close the gap between them upon release of an externally applied contact separating force.

Movable contact 11 (and its counterpart 11') extend into a housing 18 which encloses linkage mechanism 49, and are each attached to a coupling mechanism 48 and 48', respectively, which is part of linkage mechanism 49. The movable contacts 11 and 11' are actuated substantially simultaneously in opposed directions inwardly and outwardly of their respective envelopes.

Linkage mechanism 49 also comprises a bolt 50 connected to shaft 13; a pair of arms 20 and 20' each pivotally connected at one end to bolt 50 by a pin 21; a pair of arms 28 and 28' each connected at one end to the other end of 20 and 20' by pins 22 and 22', respectively, and connected at the other end to ears 29 and 29' by pins 30 and 30', respectively; and a biasing spring 54 connected to the top of bolt 50 by an ear 52 and to housing 18 by an ear 51. Biasing spring 54 provides the necessary tension along shaft 13 to maintain cam follower 72 against the surface of cam 63.

As the cam follower follows cam 63, it reciprocally moves shaft 13. This movement is transferred by pin 21 to pin 22.

Pin 22 moves horizontally in response to the vertical movement of shaft 13 because it pivots about pin 30 as pin 21 moves up or down. The movement of pin 21 by shaft 13 is caused by the change of position of cam 63 as it affects cam follower 72 and biasing spring 54.

Pin 22 is connected to coupling mechanism 48 at a closed end 27 of a tube 23. A spring 26 is located inside tube 23 and is compressed between closed end 27 and contact 11 which extends into the tube. A pin 24 is attached to contact 11 and extends outward radially through a slot 25 in tube 23. A collar 33 surrounds the contact for purposes of making the necessary electrical contact with contact 11.

Movable contact 11 is shown in the closed position. To open the contact, shaft 13 would be moved upwardly by the effect of biasing spring 54. This would cause pin 22 to move to the left thereby pulling closed end 27 away from contact 11. This would move tube 23 to the left until the edge of slot 25 contacted pin 24 and moved contact 11 to the open position.

To close the contact, tube 23 would compress spring 26 to move the contact. Spring 26 is under sufficient

compression to move contact 11 before pin 24 contacts the left edge of slot 25. By relying on the compression of the spring to effect the closing, contact rebound and overtravel can be effectively controlled.

Shaft 13 comprises an insulating portion 13a, a lower portion 13b, and a coupling portion 13c. Portion 13a is connected in axial arrangement between portions 13b and 13c with portion 13b extending into housing 18. Portion 13b comprises a cylindrical cap 31 which slips over the end of shaft portion 13a and is attached thereto by a pin 32. Cap 31 is connected to linkage mechanism 49 by bolt 50. Portion 13c connects at its lower end to cam follower structure 62.

Cam roller 72 rides along the circumferential surface of cam 63. A step portion 55 of the cam surface provides a means for quickly moving the cam roller to one position upon rotation of the cam.

Free wheeling clutch 65 is utilized to transfer the rotation of drive shaft 64 to sleeve 56 and to allow rotation of sleeve 56 in the direction of rotation free of the drive shaft. Clutch 65 comprises a pin 57 extending radially outward from drive shaft 64 to engage a pawl 58 on sleeve 56. Drive shaft 64 is shown in the figures in a position where pin 57 is just about to engage pawl 58 for rotation of sleeve 56.

In the operation of actuating means 16, motor 66 rotates drive shaft 64 in a clockwise direction. Starting with the position of cam 63 as shown in FIGS. 1 and 2, motor 66 rotates drive shaft 64 until pin 57 engages pawl 58 to rotate cam 63. When the cam is rotated sufficiently, cam roller 72 rides past step portion 55 to a first position and is pulled upwardly by biasing spring 54 to open the contacts. Motor 66 may then be automatically turned off by any known means (not shown) in response to the opening of the contacts.

To close the contacts, motor 66 is again energized and rotates the cam 63, through clutch 65, until pin 69 on arm 68 is rotated to a second or intermediate position slightly more than 180° from the position shown in FIG. 1. At this point tension spring 70 pulls arm 68 and cam 63 rapidly clockwise to a third position, the position shown in FIGS. 1 and 2, to close the contacts. To accurately stop the rotating cam, particularly to prevent step portion 55 from rotating to cam follower 72, motion transfer pendulum 74 is struck by arm 68. Pendulum 74 rises by an amount sufficient to absorb the energy or inertia of rotation of the rotating components and accurately stop the cam. Pendulum 74 then falls back to rest upon pendulum stop 76. Motor 66 may be automatically turned off by any known means (not shown) in response to the closing of the contacts.

FIGS. 3 and 4 show another embodiment of switch actuating means 16 of this invention wherein quick opening of the contacts in response to an external signal or force is provided for. FIGS. 1, 2, 3 and 4 have like reference numerals for like parts. Cam 63, in the position held by the biasing effect of tension spring 70, is positioned so that cam follower 72 would normally be pulled upwardly by spring 54 against the lower part of the cam surface to open the contacts. In this embodiment, connecting means 53 comprises a quick trip means 80 for maintaining the cam follower away from the cam surface so that a contact closed position will be maintained despite the position of the cam. The quick trip means comprises a quick trip lever 81, a quick trip solenoid 82, a retaining spring 83, a bell crank 84, and a roller 85. Bell crank 84 connects with shaft 13 at a pin 86 and connects with housing 18 at a pivot 88. The bell crank rotates about pivot 88. An extension 87 is shown which may be used for transferring the motion to other switches or switch modules.

In the operation of the embodiment shown in FIGS. 3 and 4, the motor rotates clockwise to move cam 63 to a first position (slightly over 180° from the position shown) and biasing means 60 rotates it to a second position (as

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shown). This rotation to the second position moves cam roller 72 downward to close the contacts. The second position is past cam step portion 55. However, the quick trip means maintains the contact closed position with the cam in the second position because as the cam roller is pulled downward by the cam surface, it also pulls down on pin 86 on bell crank 84 to rotate the bell crank about pivot 88 thereby raising roller 85. As roller 85 is raised retaining spring 83 pulls trip lever 81 under roller 85 and maintains the position of linkage 49 and the contacts against the tension of biasing spring 54. The trip lever maintains the closed position of the switch until activated by an external force, such as an electric current flow through solenoid 82, that causes trip solenoid 82 to move the lower end of trip lever 81 (as shown in the drawing) to the left thereby freeing the bell crank for rotation about pivot 88 in response to the tension of biasing spring 54. This quickly allows biasing spring 54 to effect the opening of the contacts and performs as a quick disconnecting or quick opening device. Bell crank 84, roller 85, trip lever 81, and retaining spring 83 cooperate to automatically reset the quick trip means upon rotation of the cam to the first position because as cam roller 72 is moved downward by the surface of cam 63 the upper part of trip lever 81 will move under roller 85 and prevent any transfer of upward motion by shaft 13 to linkage 49.

The rotation of cam 63 is accomplished in the same manner as the embodiment of FIGS. 1 and 2 in that the cam is rotated clockwise to the position where offset extension is just 180° from the position shown in the drawings. At this point, biasing spring 70 causes the shaft to rapidly rotate to the position shown and the momentum of the rotating shaft and structure is absorbed by motion transfer pendulum 74.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A circuit breaker comprising a contact movable to two positions, a cam, a connecting means connected to the contact and responsive to the position of the cam to move the contact to the two positions, first driving means connected to the cam for rotating the cam to a first position, said connecting means responsive to said first position of the cam to move the contact to one position, and second driving means connected to the cam for rotating the cam independently of the first driving means to another position, said connecting means responsive to said another position to move the contact to the other position.

2. A circuit breaker comprising a contact movable to two positions for opening and closing a circuit; a cam; connecting means connected to the contact and responsive to the position of the cam to move the contact; first driving means connected to the cam for rotating the cam to a first position, said connecting means responsive to said first position of the cam to move the contact to one position; and second driving means connected to the cam for rotating the cam from one position to another position independently of the first driving means, said connecting means responsive to said another position of the cam to move the contact of the other position, and said second driving means comprising an inertia absorbing means for stopping rotation of the cam upon movement of the cam to said another position.

3. In combination, a switch with a contact movable to two positions; a cam; connecting means connected to the contact and responsive to the position of the cam to move the contact to both positions; driving means connected to the cam for rotating the cam to one position to effect movement of the contact to one position and for rotating the cam to an intermediate position; biasing means connected to the cam for rotating the cam from the intermediate position to another position independently of the driving means to effect movement of the con-

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tact to the other position; and an inertia absorbing means for stopping the rotation of the cam by the biasing means at the other position upon movement of the contact to said other position.

4. In combination, a movable contact having an open and a closed position; a cam; driving means for rotating the cam to a first position and a second position; biasing means connected to the cam for rotating the cam from the second position to a third position; connecting means responsive to the position of the cam and connected to the contact to move the contact to a contact open position when the cam is in the first position and to a contact closed position when the cam is in the third position; and inertia absorbing means for stopping the cam at the third position.

5. In combination, a movable contact having a contact open and a contact closed position; a cam having a circumferential surface driving means connected to the cam for rotating the cam to a first position and a second position; biasing means connected to the cam for rotating the cam from the second position to a third position and for maintaining the cam in said third position; a cam follower biased against the circumferential surface of the cam, said cam follower connected to the contact and responsive to the position of the cam to move the contact to the open position when the cam is in the first position and to the closed position when the cam is in the third position; and inertia absorbing means for stopping the rotation of the cam at the third position.

6. In combination, a movable contact having a contact open and a contact closed position; a cam having a circumferential surface; driving means for rotating the cam to a first position and a second position; means connected between the cam and the driving means for allowing rotation of the cam free of the driving means in the direction of rotation; biasing means connected to the cam for rotating the cam from the second position to a third position and maintaining the cam in said third position; a cam follower biased against the circumferential surface of the cam, said cam follower connected to the contact and responsive to the position of the cam to move the contact to the open position when the cam is in the first position and to the closed position when the cam is in the third position; an arm rigidly connected to the cam; and a motion transfer pendulum supported at an axis and located to be contacted by said arm when the cam attains the third position to absorb the inertia of rotation.

7. In combination, a movable contact having a contact open and a contact closed position; a cam having a circumferential surface; a motor; means connecting the cam and the motor for rotating the cam to a first position and a second position in response to rotation of the motor and for allowing rotation of the cam free of the motor in the direction of rotation; a spring connected to the cam to rotate the cam from the second position to a third position; a cam follower biased against the circumferential surface of the cam, said cam follower connected to the contact and responsive to the position of the cam to move the contact to the open position when the cam is in the first position and to the closed position when the cam is in the third position; an arm rigidly connected to the cam; and a motion transfer pendulum supported at an axis and located to be contacted by said arm when the cam is biased by the spring to the third position to absorb the inertia of rotation.

8. In combination, a switch with a movable contact having an open and closed position; a rotatable cam having a circumferential surface; driving means for rotating the cam to a first position; biasing means connected to the cam for rotating the cam from a first position to a second position and maintaining the cam in said second position; and connecting means connected to the contact and responsive to movement of the cam to move the contact to the closed position when the cam is moved to the

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second position and responsive to the second position of the cam to move the contact to the open position when the cam is in the second position, said connecting means comprising a quick trip means for maintaining the contact closed position when the cam is in the second position; said quick trip means responsive to an external signal to release and thereby allow movement of the contact to the open position in response to the second position of the cam, and said quick trip means connected to automatically reset to maintain the contact closed position upon rotation of the cam to the second position of the cam.

9. In combination, a movable contact having an open and closed position; a cam having a circumferential surface; driving means for rotating the cam to a first position; biasing means connected to the cam for rotating the cam from a first position to a second position and maintaining the cam in the said second position; a cam follower biased against the circumferential surface of the cam, said cam follower connected to the contact and said circumferential surface adapted to move the contact to the closed position in response to movement of the cam to the second position and to move the contact to the open position in response to the second position of the cam; and quick trip means connected to the cam follower for maintaining the cam follower away from the cam surface to maintain the contact closed position when the cam is in the second position, said quick trip means responsive to an external force to quickly disconnect from the cam follower for allowing quick movement of the cam follower to the cam surface to open the contact.

10. In combination, a movable contact having an open and closed position; a cam rotatable about an axis and

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having a circumferential surface about the axis; a motor; a free wheeling clutch connecting the cam and the motor for rotating the cam to the first position in response to rotation of the motor, said clutch adapted to allow rotation of the cam free of the motor in the direction of rotation; a spring connected to the cam for rotating the cam from the first position to a second position and maintaining the cam in said second position; a cam follower biased against the circumferential surface of the cam, said cam follower connected to the contact and said cam surface adapted to move the contact to the closed position in response to movement of the cam to the second position and to move the contact to the open position when the cam is in the second position; and quick trip means connected to the cam follower for maintaining the cam follower away from the cam surface when the cam is in the second position, for releasing the cam follower in response to a signal to allow the cam follower to move to the cam surface to move the contact to the open position, and for automatically resetting to maintain the cam follower away from the cam surface upon rotation of the cam to the first position of the cam.

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