Nov. 13, 1962 F. G. NICOLAUS 3,064,098

ELECTRICAL SWITCH MECHANISM

Filed Feb. 3, 1960

Fig. 1.

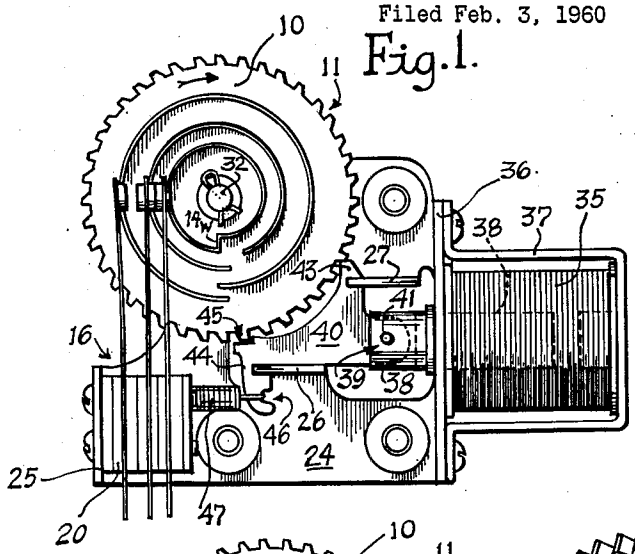
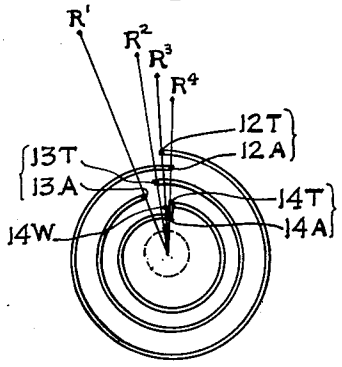


Fig. 6.



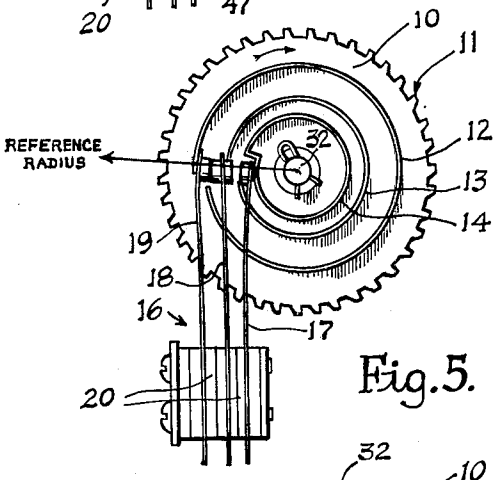


Fig. 5.

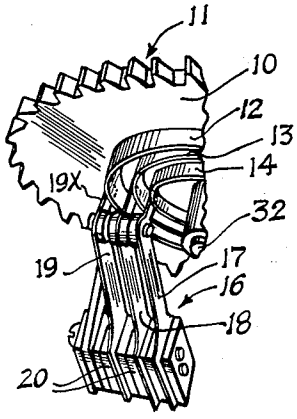


Fig. 4.

Fig. 3.

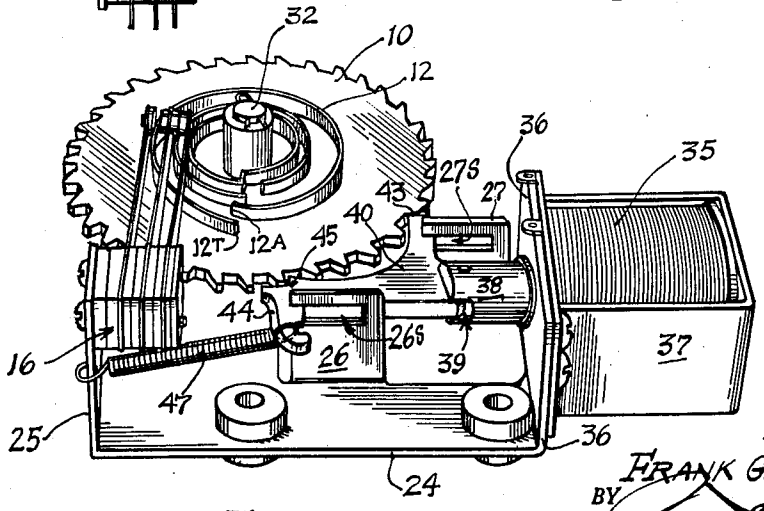


Fig. 2.

INVENTOR.
FRANK G. NICOLAUS
BY
ATTORNEY.

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ELECTRICAL SWITCH MECHANISM

Frank G. Nicolaus, Chicago, Ill., assignor to Lion Manufacturing Corporation, Chicago, Ill., a corporation of Illinois

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This invention relates to improvements in electric switches of the type actuated by a spiral cam, and has as its principal object the provision in such a device of a novel spiral cam means making possible multiple-contact operation with snap action and a unidirectional resetting or recycling action.

It is a further object to provide a switch of the class described having at least a single-pole, double-throw, snap action with heavy contacts capable of carrying relatively heavy current loads suited for use in connection with various utility devices such as refrigerators, washing machines, and the like, and especially characterized by such features as simplicity, reliability, low cost, and heavy load-carrying capacity, but requiring relatively low operating power.

It is a particular object also to provide a spiral cam type of switch in which a plurality of contact blades comprising a cooperative set each cooperating with one of a plurality of concentric spiral tracks having especially contrived drop-off formations so arranged and constructed as to cause the blades to shift contacting positions with a snap action as a result of unidirectional rotation of the spiral track system, and to be recycled and restored to an initial condition as a result of continued unidirectional movement.

Additional objects and aspects of novelty and utility will appear as the following description proceeds in view of the annexed drawing in which:

FIG. 1 is an elevational view of one form of the novel switch;

FIG. 2 is a perspective of the same;

FIG. 3 is a plan detail of one of the contact blades;

FIG. 4 is a fragmentary perspective of the spiral tracking member and contact assembly;

FIG. 5 is a plan detail of the switching means showing the contacts in readiness for a change of position;

FIG. 6 is a diagram of the cam tracks.

The principal features of novelty characterizing the new switch relate particularly to the form and mode of operation of the switch contact blades and the spiral tracking member, as depicted in FIGS. 3, 4, and 5, the latter view showing the ratchet member as a wheel **10** which is preferably molded from nylon and has suitably pitched ratchet teeth **11** about its periphery, as well as a series of concentric, integrally-formed, spirally-evolved ridges or tracks **12**, **13**, and **14**, and formed on at least one face theerof.

Cooperable with the tracking member is a stack-type switch **16** (FIGS. 4 and 5) comprising a set of spring contact blades **17**, **18**, and **19** secured at one end in the usual pile-up of insulating wafers **20**.

The contact blades are detailed in FIG. 3 and are particularly characterized in that they are provided at their free ends with lateral wings or projections, e.g. **17X**, adapted to ride on one of the tracking ridges or formations on the ratchet wheel, in the manner particularly illustrated in FIG. 4.

A complete switch unit is shown in FIG. 1 and comprises a stamped base member **24** having an upset flange portion **25** upon which the stack switch **16** is mounted, as well as a stub spindle **32** upon which the ratchet wheel **10** is journalled.

An electromagnetic solenoid **35** is mounted upon another base flange **36** (FIG. 2 also) by means of a bracket

37, and has its plunger **38** slotted and pierced as at **39** at the free end to receive the end of a combination stepping and indexing pawl **40**, which is rockably attached thereto by means of a roll pin **41**.

Two guide flanges **26** and **27** are also struck up from the base plate so as to lie in parallel planes, and each such flange has a long guide slot **26S** or **27S** (FIG. 2) formed therein in parallelism with the like slot in the other.

The pawl member **40** is also preferably molded in one piece from nylon, and has two divergent arms **43** and **44** each riding in one of the guide slots **26S** or **27S**, as depicted in FIG. 2.

At the upper end of pawl projection **44** is a notch **45** constituting a driving tooth engageable in the teeth of the ratchet wheel, while the opposite end portion of this projection is pendant and rides in the guide slot **26S** and is also notched as at **46** to provide a lug to which a driving and return spring **47** is attached, the opposite end of this spring being suitably anchored on the base plate.

The free end of the other or index pawl projection **43** also engages in the ratchet teeth in the manner shown in FIG. 1, and affords a dead-stop and indexing means to assure positive arrest of the ratchet wheel always at the same relative position, this projection riding in the upper guide slot **27S**. This one-piece stepping and index pawl guiding means **40**, **43**, **44**, **26S**, **27S** is disclosed and claimed in my application Serial No. 772,505, filed November 7, 1958.

Referring to FIG. 1, a novel switching action is achieved by means of a special shaping of the cam tracking formations, in the respect that said formations, whether they be ridges or grooves, are evolved spirally about the same center coinciding with the rotative axis through the spindle **32**; and each track or ridge has an outer or evolutionary terminus **12T**, **13T**, or **14T**, spaced angularly and radially from its own origin **12A**, **13A**, or **14A**, substantially as shown in FIG. 1 or the diagram of FIG. 6 wherein it will be observed that, whereas the terminus **14T** of the inner track does in fact lie on approximately the same radius R^4 with its origin **14A**, nevertheless the other termini and origins all lie on different radii.

Terminus **14T** and origin **14A** of the innermost track not only lie substantially on the same radius R^4, but they are interconnected by a short radial blocking web **14W**, the purpose of which is to prevent entry of the inner contact blade wing **17X** into the dead zone surrounding the spindle where a jam up could be caused should the wheel be turned in the wrong direction.

It will also be observed that the several termini **12T**, **13T**, **14T** each lie on a different radius R^3, R^2, R^4, respectively.

As a result of the foregoing especially contrived track configurations, there is an angular gap left between the origin and terminus of each of the two spiral outer track formations, but none on the innermost spiral **14, and** the several gaps are offset from each other in an angular or circumferential sense, from which it follows that the several track termini **12T**, **13T**, and **14T**, are mutually angularly offset from each other, and since these portions of the tracks constitute the drop-off points for the riding wings **17X**, etc. on the contact blades, it will be apparent that the drop-off movements of the switch blades will occur in the sequence of the termini, i.e. **14T**, **12T**, **13T**, as the ratchet wheel **10** turns clockwise, because the first drop-off to be effectively presented to a blade is the inner one (**14T**).

The blade action last described results in a switching sequence as follows: The relationship of the three contacts, while the ratchet wheel is moving through the long principal phase of its cycle, will be as depicted in FIG. 1, with the inner and middle contacts **17—18** "made" or in

closed-circuit engagement and the outer contact **19** in open-circuit condition. As the cycle nears its end and the last ratchet step is taken, two actions occur in very rapid succession, namely, the inner blade **17** drops off in about the first half of this step and breaks its contact with the middle blade **18**, and then as the last half of this last step is taken the outer blade **19** drops so that the condition shown in FIG. 5 prevails, but the FIG. 5 condition lasts only until the next step is taken, whereupon the middle contact **18** again springs down into engagement with the inner contact **17** so that the cycle starts over and the condition of FIG. 1 again exists for the major phase of ratchet travel through another 330 degrees, more or less, there being 36 ratchet teeth on the embodiment shown, and the described contact action being completed in a range of about 30 degrees of total drop-off displacement, the width of the gaps and amount of angular offset thereof having a bearing on this range.

In summary, due to the described radial offsetting and angular gapping of the set of concentric spiral tracks, the action is such that the middle and innermost contacts are "made" during a predetermined major portion of the ratchet wheel travel, but near the end of each cycle. The inner contact first drops off and breaks with the middle contact during the first part of the last step, and instantly thereafter the outer contact drops off and "makes" with the middle contact as this last step is being completed. On the first step next following the middle contact breaks away from the outer contact and reengages the inner contact, and a new cycle begins.

The aforesaid drop-off sequence may be changed so that the outer blade drops to contact the middle blade and simultaneously therewith the inner contact falls away from the inner blade. This may be achieved simply by shifting the outer terminus slightly clockwise.

In general, the switching action may be varied by manipulation of three factors, namely: the number of spiral tracks, the spacing between tracks in a radial sense, and the arrangement or angular spacing of the gaps and termini. The width of the gaps is of consideration mainly as respects keeping the angular distance or width across the gap small so as to utilize as much of the 360° arc of travel as possible.

The novel switching mechanism makes it possible to utilize heavy contacts and heavy spring pressures because the spiral cam action relieves the instantaneous load. Thus, a unit such as illustrated requires only two watts of operating power per step and can be stepped rapidly or at very long intervals.

I claim:

1. In a switch of the class described, a ratchet wheel, electromagnetically powered stepping means for advancing said wheel step-by-step, a plurality of spiral cam tracks evolved concentrically of the center of rotation of said wheel and each having opposite ends designated respectively as starting and terminal ends which are so arranged that the said ends of each track are brought into close juxtaposition with respect to each other and a corresponding reference radius from said center which is slightly displaced angularly relative to the reference radius for any other track so as to provide a predetermined number of drop-off steps for an associated contact means; together with a plurality of contact members arranged to extend in approximate parallelism in the general direction of a chord of said wheel; said contact members being at least three in number and being spring-biased toward said center and tracks and each having a riding portion bearing against one of said tracks by reason of said spring bias and each so constructed and arranged with respect to the radial spacing of said tracks and the drop-off steps thereof that in each cycle of revolution of said wheel at least two of said contacts will be electrically engaged during a substantial portion of the range of angular travel of said ratchet wheel until the latter is moved to advance one of said drop-off steps into position to permit a first one of said two engaged contacts to snap away from the other, and substantially concurrently therewith to release a third said contact to spring into engagement with said other contact; and upon a still further movement of said wheel to cause said other contact to disengage said third contact and reengage said first contact, with repetitions of said cycle by like advances of the ratchet wheel.

2. A switching device having a rotary member with concentric spirally-evolved tracks thereon each having an origin and a terminus, the termini constituting contact drop-offs; cooperative contact members each having a riding part and mounted relative to the rotary member, and biased toward the axial rotative center of the latter, such that the several riding parts each ride an appertaining one of said cam tracks and tend to drop off the respective termini thereof on turning of the rotary member appropriately, the respective origins and termini of the several tracks being gapped apart angularly a distance to permit the appertaining contact riding parts to drop therethrough; said termini being angularly offset relative to each other in a predetermined manner to cause the drop-off actions for the respective blades to occur in a predetermined sequence.

3. In a rotary type switch having contact blades with parts adapted to be actuated by riding a spiral tracking formation moved about the axis of rotation thereof, improvements comprising, namely: a spiral tracking member for actuating a plurality of contact blades in predetermined sequence and comprising a plurality, equal to the number of contact blades to be actuated, of formations evolved spirally about said axis; contact means including a riding part each arranged to ride one of said formations, means biasing each contact means to cause the appertaining riding part to bear yieldingly against the appertaining track formation in a radial sense; each said formation having a gap in the arc thereof providing a drop-off formation for the appertaining riding part whereby the latter and the corresponding contact means is caused to move in a radial sense relative to another said contact means, the several drop-off formations being spaced apart in a direction around said axis.

4. A switching device comprising a rotatable member and means for moving same about its axis of rotation; at least three spiral tracks on said member evolved about said axis each track having an origin with a terminus lying farther out radially than its origin and located on a radius which is close to, but spaced from, a radius containing the corresponding origin by a predetermined small number of degrees so as to provide an appertaining drop-off gap for each track; and a set of contacts each having a riding member adapted to bear in a radial sense upon an appertaining one of said tracks; means mounting said contacts so that the respective riding members thereof lie one after another along a narrow radial zone outwardly from said axis, said contacts being spring-biased toward said axis so as to shift toward the latter on passing from the drop-off terminus of the appertaining tracks, said gaps being angularly offset so as to cause said contacts to drop off in a predetermined order for circuit changing engagement and disengagement in cyclic rotation of the rotatable member.

5. A spiral cam switch comprising a rotatable carrier having a plurality of tracking formations each extending in a direction spirally about the axis of rotation of the carrier and spaced one from another in directions radial to said axis, and each having a gap opening therethrough in radial directions to provide contact drop-offs; a plurality of cooperative contact blades fixed in position adjacent said carrier to move in switching action along lines radial to said axis each blade having a track-riding part; means spring-biasing said blades to press in a radial direction and ride an appertaining one of said tracking formations and adapted to move in drop-off switching action from the appertaining drop-off responsive to rotative displacement of the carrier whereby to change

switching engagement with another said contact, said gaps being located relative to each other at predetermined angular locations about said axis to effect said drop-off switching actions at correspondingly different times during such rotative displacement.

6. Apparatus as set forth in claim 5 further characterized in that said tracking formations are similarly evolved about said axis from respective points of origin to lie at substantially increasing radial distances from said axis progressively thereabout, whereby to progressively increase the tension on said blades as said carrier turns in the direction of said radial increase from said origin such that the said drop-off actions will occur with a snap action.

7. A spiral cam switch comprising a rotatable carrier member having a plurality of concentric, radially spaced-apart tracks each evolved spirally about the axis of rotation of said member and each containing a gap located along a radius which is shifted angularly relative to other such gaps to provide a plurality of contact drop-offs, and a plurality of cooperative contact members fixed adjacent said carrier and each spring biased in a radial sense relative to said axis and each having a member pressing in a radial sense to ride one of said tracks under drop-off tension and adapted to snap from the appertaining gap on appropriate angular movement of said carrier member and change switching engagement with at least one cooperative contact, said gaps being situated at different angular positions to cause the said drop-off movements to occur at different angular positions of said carrier member.

8. A spiral cam type of switch comprising a rotatable member adapted to be rotated unidirectionally and having a plurality of independent, spirally-evolved tracks arranged about the center of rotation of said member and substantially spaced apart one from another along lines radial to said center, their spirals increasing along radial lines in the direction of rotation of said member, a set of switch contacts each having a tracking member positioned to follow one of said tracks, said contacts all being spring-biased to cause said tracking members to bear radially and yieldingly in following engagement with the appertaining track in a predetermined radial drop-direction; each track having a step dropping in said drop direction and said step being respectively situated at predetermined locations angularly about said center such that during one revolution of said rotatable member said contacts will drop from the appertaining track steps and a starting switching condition in a change-switching action in a predetermined order and will reengage their respective tracks and be returned to said starting condition on continued movement of said rotatable member in a succeeding revolution.

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