

July 4, 1961

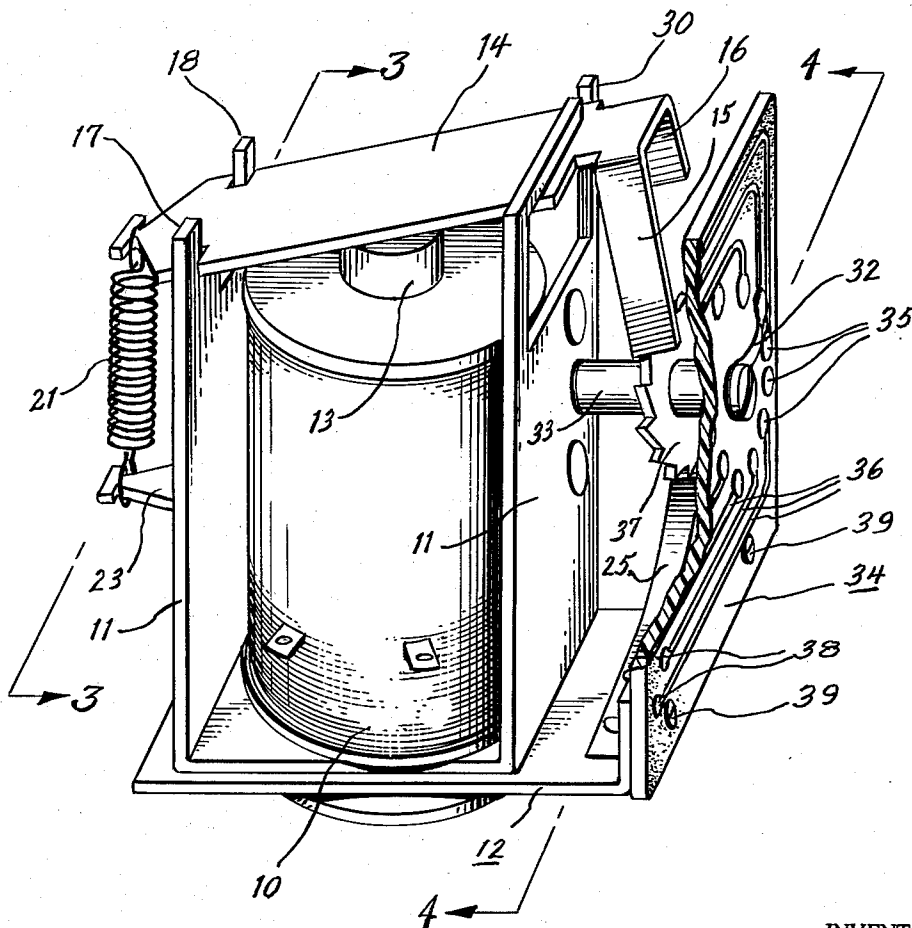
C. J. HOLPUCH
STEPPING SWITCH

2,990,723

Filed June 2, 1958

3 Sheets-Sheet 1

Fig.1



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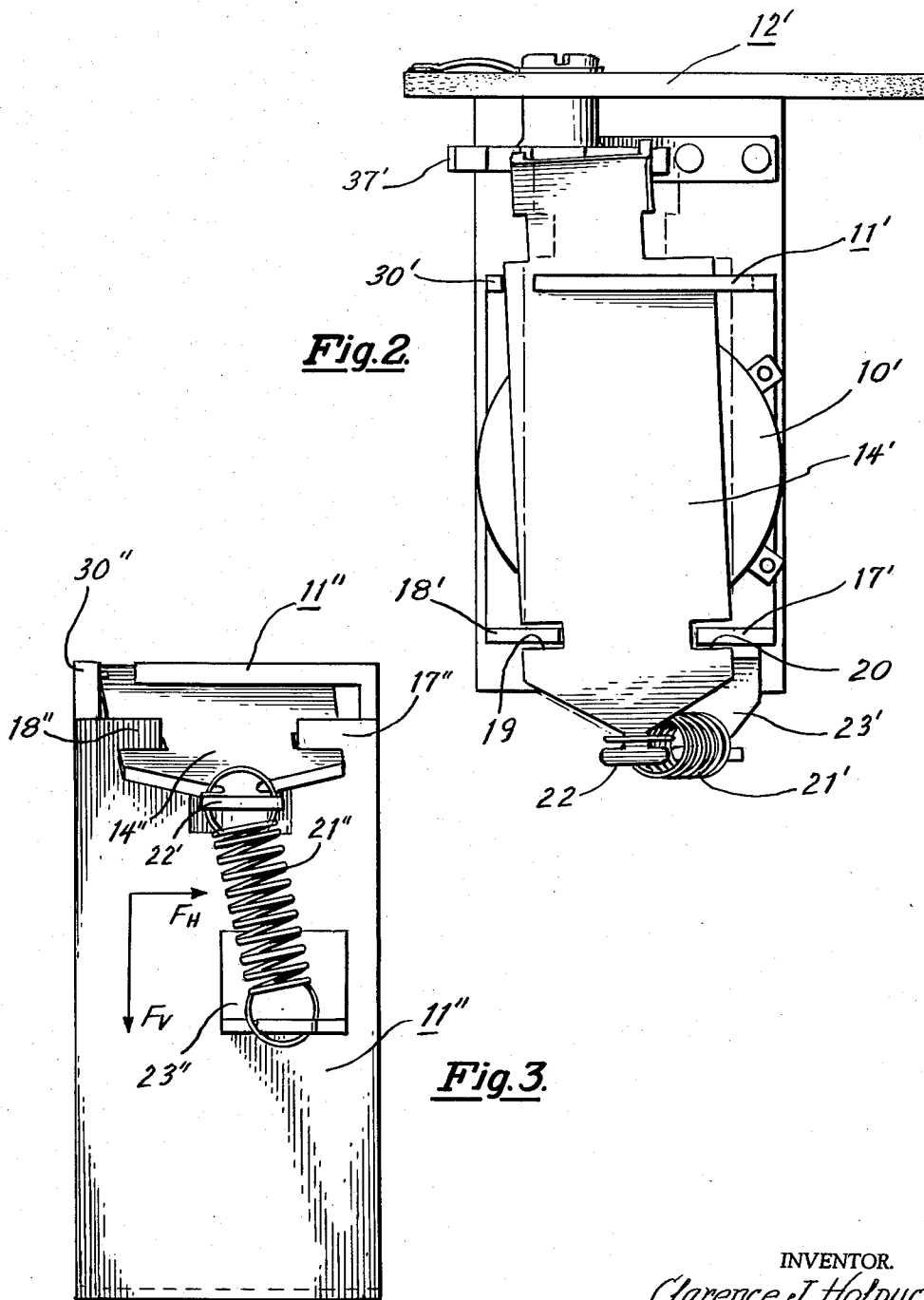
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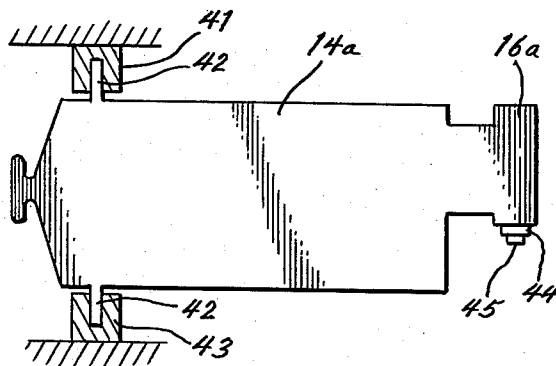
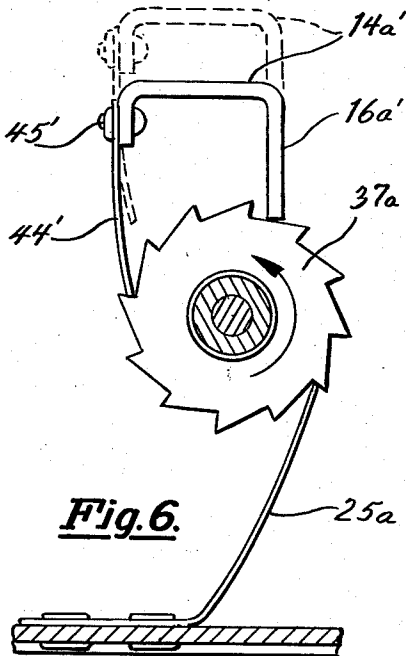
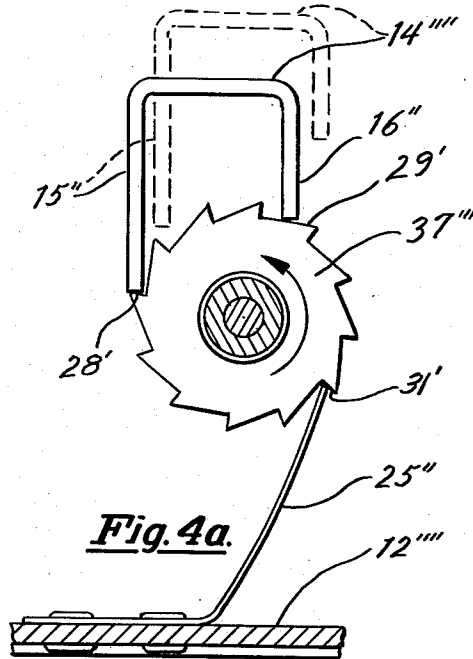
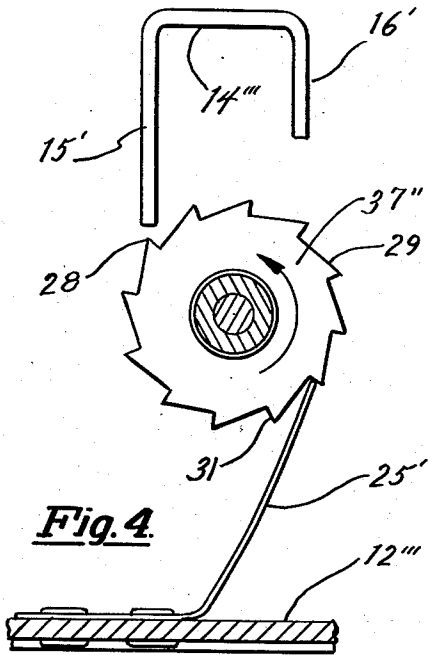
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3 Sheets-Sheet 3



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2,990,723

STEPPING SWITCH

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2 Claims. (Cl. 74-142)

This invention relates, generally, to stepping switches, and more particularly to a simplified electromagnetic stepping switch of the type employing a ratchet wheel and a pawl.

There are, in the prior art, many different types of electromagnetic stepping switches using a relay, a pawl operated by the relay, and a ratchet wheel operated by the pawl. It is desirable, ordinarily, to accomplish three different functions with respect to the ratchet wheel. Firstly, it is desirable to rotate the ratchet wheel a certain angular distance by means of the pawl in response to a single input signal supplied to the relay. Secondly, it is desirable to prevent the ratchet wheel from overshooting the desired angular distance due to the momentum imparted thereto by the action of the pawl. Thirdly, it is desirable to prevent "backlash" of the ratchet wheel when the pawl is disengaged therefrom. These three functions ordinarily are performed by separate and distinct structures. For example, the "backlash" preventing function often is performed by means of a flat spring member secured at one end and having its free end resting against the toothed edge of the ratchet wheel. The rotation of the ratchet wheel usually is produced by the action of the pawl which can be affixed to the relay armature, and the overshoot prevention function is produced sometimes by damping means, or sometimes even omitted.

Now it is a primary aim of the present invention to provide a stepping switch in which the rotation of the ratchet wheel and the means for preventing overshoot are integral with the relay armature.

Another object of the invention is to provide a simple means for preventing overshoot of the ratchet wheel.

Other objects of the invention are to provide a simple, reliable, and inexpensive stepping switch and in general to improve stepping relays.

In accordance with the invention, there is provided a supporting frame, a relay winding means mounted upon said supporting frame, and a relay armature positioned across one end of said relay winding means and loosely and pivotally mounted at one end thereof upon said supporting frame to permit pivoting in limited arcs towards and away and from the winding means and also transversely to the winding means. The said relay armature is constructed to have first and second pawls formed integrally therewith at the other end thereof. First spring means are provided to bias the armature away from the winding means and in a first transverse position. A ratchet wheel is constructed and arranged to be engaged by said first pawl in response to the movement of the armature toward said winding to rotate a predetermined angular distance.

The said second pawl is constructed and arranged to engage said ratchet wheel after said first pawl has caused rotation thereof a predetermined angular distance to prevent further rotation thereof. Second spring means are constructed to engage the ratchet wheel to prevent "backlash" thereof.

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Important features of the invention are the formation of the first pawl integrally with the armature and the loose mounting of the armature to permit said first pawl to ride around the perimeter of the ratchet wheel as it rotates. Another important feature of the invention is the formation of the second pawl integrally with the armature. The last-mentioned feature constitutes a subcombination, as follows.

In accordance with another form of the invention, the armature can be mounted at one end thereof to pivot in one plane only. The first pawl is of a spring material in order to follow the perimeter of the ratchet wheel as said wheel rotates. The said second pawl is formed integrally with the armature and functions, as described supra, to limit the amount of rotation of the ratchet wheel.

The above-mentioned and other objects and features of the invention will be understood more fully when read in conjunction with the drawings, in which:

FIG. 1 shows a perspective view of the invention;

FIG. 2 shows a plan view of the top of the structure of FIG. 1;

FIG. 3 shows a plan view taken along the plane 3-3 of FIG. 1;

FIGS. 4 and 4a show partial plan views of the stepping switch taken along the plane 4-4 of FIG. 1, and

FIGS. 5 and 6 show partial plan views of an alternative form of the invention and employing a relay armature mounted at one end so as to be pivotal in one plane only and having a flexible pawl for rotating the ratchet wheel.

It is to be noted that throughout the several figures shown herein, similar elements will be identified by the same reference character, although primed in succeeding figures.

Referring now to FIG. 1, the coil wound relay winding 10 is mounted on a bracket or supporting means 11, which in turn is mounted on another bracket or supporting means 12. A core 13 of magnetic material extends beyond the upper end of the winding 10. An armature 14, having two pawl elements 15 and 16 thereon, is actuated by the relay winding 10 and the core 13. More specifically, when the winding 10 is de-energized the armature 14 is caused to be in its "up" position by the action of tension spring 21, as shown in FIG. 1, and when the winding 10 is energized the arm 14 is magnetically drawn to the bar 13 and assumes its "down" position. (See FIGS. 4 and 4a.) The arm 14 is pivoted loosely on the bracket 11 between the legs 17 and 18, so that the arm 14 can move not only up and down, but can also move sidewise with respect to the axis of winding 10. Such sidewise motion is important, since it permits the pawl 15 to ride with the ratchet wheel 37, as said ratchet wheel is caused to rotate due to the pawl 15 being forced down upon it. This action will be described in detail later.

Returning now to the pivoting means for the arm 14, reference is made to FIGS. 2 and 3. In FIG. 2, which is a top view of FIG. 1, the lateral positions of the arm 14 are shown when the arm 14 is in its "up" position (solid line) and when the arm is in its "down" position (dotted line). It can be seen that the notches 19 and 20 in the arm 14 are sufficiently large to permit the "sidewise" (or lateral) motion necessary to the operation of the device. As indicated herein before, when the wind-

ing 10 is de-energized the arm 14' is caused to assume its "up" position (as shown by the solid line in FIG. 2) due to the action of the tension spring 21', which is shown more clearly in FIG. 3.

More particularly, it can be seen that one end of spring 21' is secured to the arm 14' near the end thereof by some convenient means, such as the narrowed portion 22' of said arm. The other end of the spring is secured to the bracket 23', which in turn is secured to the bracket 11". It will be apparent that the spring 21' exerts a vertical force F_v and a lateral force F_h upon the end of the arm 14' to cause the arm 14 to assume the solid line position of FIG. 2 when in its "up" position.

Referring now to FIGS. 4 and 4a, the action of the arm 14 with respect to the ratchet wheel will be discussed. In FIG. 4, the arm is shown in its "up" position. The spring 25' prevents the wheel 37" from "backlash," which in this case would be rotation in a clockwise direction, but does permit rotation in a counterclockwise direction. In FIG. 4a the arm 14'" is shown in its "down" position. (The dotted line position shows the "up" position of FIG. 4.) During the course of assuming its "down" position the pawl 15" engages the gear tooth 28' of the ratchet wheel and rotates said wheel through a small angular distance (about $27\frac{1}{2}^\circ$). It will be observed that the pawl 15", and thus the arm 14'" are forced laterally to the left in FIG. 4a, as the wheel 37'" is rotated. To prevent any rotation greater than $27\frac{1}{2}^\circ$, the pawl 16" comes to rest on the gear tooth 29' in the "down" position of arm 14'"'. To prevent "backlash" the spring 25" comes to rest under the tooth 31'.

When the winding 10 is de-energized the arm 14'" will again assume its "up" position.

It is to be noted that the lateral excursion of the arm 14' to the left (see FIGS. 2 and 3) is limited by the portion 30' of the bracket structure 11'.

Referring again to the structure shown in FIG. 1, it can be seen that the ratchet wheel is mounted on a shaft 33, which in turn is rotatably supported on a contact holding plate 34. The contact holding plate 34 is mounted securely on the frame structure 12 by suitable means such as bolts 39. A sweep contact 32, which rotates with the ratchet wheel 37 is secured to the end of the shaft 33, and makes contact with consecutive ones of the equally spaced contacts 35. Adjacent ones of contacts 35 are spaced apart angular distances equal to the angular distances between adjacent teeth on the ratchet wheel 37. Leads such as leads 36 connect the contacts 35 to individual ones of the terminals 38 located at the edge of the plate 34. It is to be noted that the plate 34 may be a printed circuit board or any other suitable contact bearing plate.

Referring now to FIGS. 5 and 6, there is shown a modification of the invention. In FIG. 5, the armature 14a has fingers 42 formed thereon which fit into apertures provided therefor in mountings 41 and 43. The mountings 41 and 43 are secured to, or are part of, the general supporting structure 11 of FIG. 1. It can be seen that the arm 14a will pivot substantially only in one plane, e.g., in a plane perpendicular both to the line formed by the fingers 42 and the plane of the paper on which FIG. 5 is drawn. However, with such a pivoting arrangement, it is obvious that a rigid pawl such as pawl 15 of FIG. 1 cannot be employed therewith since such a pawl would be unable to ride around the perimeter of a ratchet wheel as the ratchet wheel rotated. The solution to the aforementioned problem is a flexible pawl, such as the pawl 44' shown in FIG. 6, which is secured to the armature 14a' and which can ride around with the ratchet wheel 37a'. In FIG. 6 the dotted line structure shows the "up" position of the arm 14a' and the solid line structure shows the "down" position of the arm 14a'. Spring 25a functions to prevent "backlash" of the wheel 37a'.

It is to be noted that the structures shown and de-

scribed herein are but preferred embodiments of the invention and that various changes may be made in their design without departing from the spirit or scope thereof.

I claim:

1. A ratchet relay comprising, a supporting frame, electromagnet means mounted on said frame and having a determinable first axis, an armature mounted for pivotal movement about a fixed second axis and for further simultaneous pivotal movement laterally of said first axis, a ratchet wheel rotatably mounted on said frame for rotation about a third axis perpendicular to both said first and said second axes, said electromagnet means when energized applying a force to said armature that is radially toward said ratchet wheel, a pair of pawls integrally formed with said armature, each of said pawls disposed laterally of said third axis with one pawl on one side of said third axis and the other pawl on the other side of said third axis, said pawls being displaced from one another at their extremities by a distance greater than the radius of said ratchet wheel and less than the diameter of said wheel, one of the pawls being longer than the other for initial engagement with said ratchet wheel to rotate the latter a predetermined angular distance upon pivotal movement toward said wheel, the other of said pawls being subsequently engageable with said ratchet wheel and cooperating with said one pawl to stop said ratchet wheel upon rotation through said predetermined angular distance, said pivotal movements of said armature permitting said pair of pawls to follow the periphery of said ratchet wheel, said frame being of U-shaped configuration having an elongated flat recess in the end of one leg and a substantially rectangular window near the top of the other leg, said armature resting in said recess near its pivot end and extending through said window near the pawl end, and a spring angularly disposed relative to said first axis for applying simultaneously restoring pivotal movement forces to said armature laterally of said first axis and about said fixed second axis to return said armature to its initial position upon deenergization of said electromagnet means, said spring being joined to said frame and to said armature outside said one leg of said frame for urging said armature into bearing contact with said recess and against the upper portion of said window.

2. A ratchet relay comprising, a supporting frame, electromagnet means mounted on said frame and having a determinable first axis, an armature mounted for pivotal movement about a fixed second axis and for further simultaneous pivotal movement laterally of said first axis, a ratchet wheel rotatably mounted on said frame for rotation about a third axis perpendicular to both said first axis and said second axis, said electromagnet means when energized applying a force to said armature that is radially toward said ratchet wheel, a pair of pawls integrally formed with said armature, each of said pawls disposed laterally of said third axis with one pawl on one side of said third axis and the other pawl on the other side of said third axis, said pawls being displaced from one another at their extremities by a distance greater than the radius of said ratchet wheel and less than the diameter of said wheel, one of said pawls being longer than the other for initial engagement with said ratchet wheel to rotate the latter a predetermined angular distance upon pivotal movement toward said wheel, the other of said pawls being subsequently engageable with said ratchet wheel and cooperating with said one pawl to stop said ratchet wheel upon rotation through said predetermined angular distance, said pivotal movements of said armature permitting said pair of pawls to follow the periphery of said ratchet wheel, said frame being of U-shaped configuration having an armature engaging portion in the end of one leg for engagement of said armature in a manner to allow said pivotal movement about said first and said second axes, and a stop portion overlying the top of said armature near said other leg, said armature extending between the end of said other leg

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and said stop portion near its pawl end and overhanging said one leg near its pivot end, and a spring angularly disposed relative to said first axis for applying simultaneously restoring pivotal movement forces to said armature laterally of said first axis and about said fixed second axis to return said armature to its initial position upon deenergization of said electromagnet means, said spring being joined to said frame and to said armature outside said one leg of said frame for urging said armature into contact with said engaging portion and against said stop portion.

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