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COUNTERBALANCE ASSEMBLY

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FIG. 1

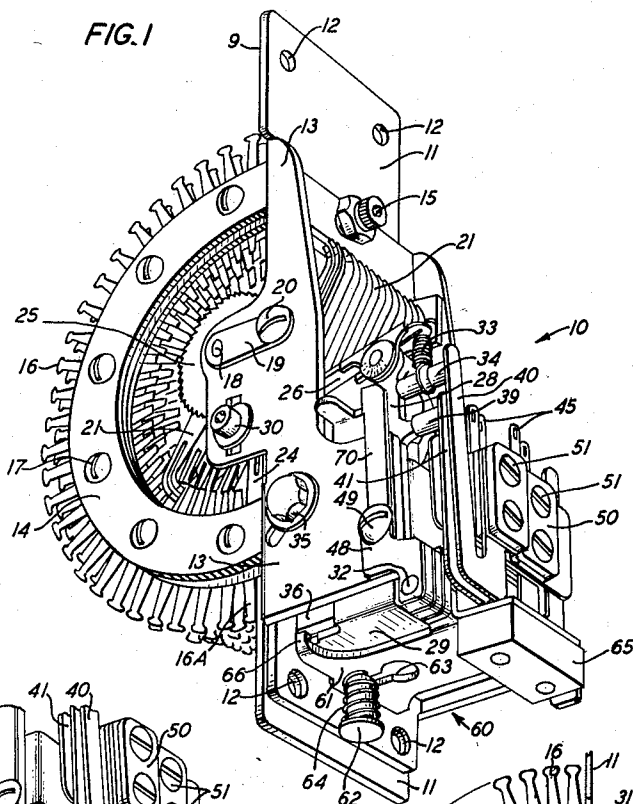


FIG. 3

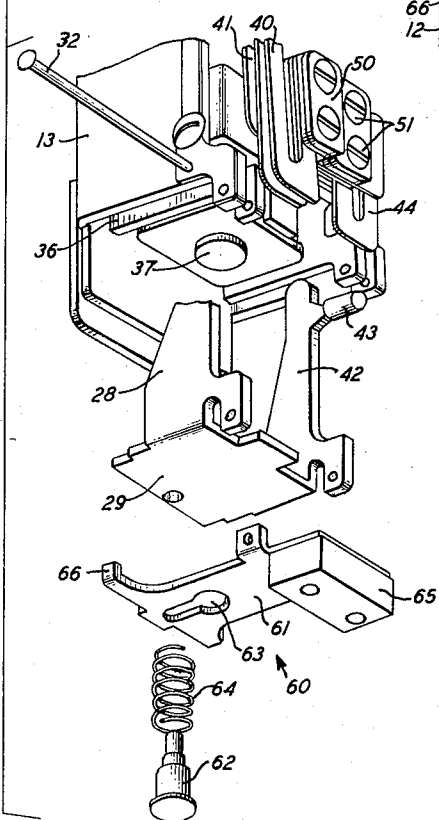
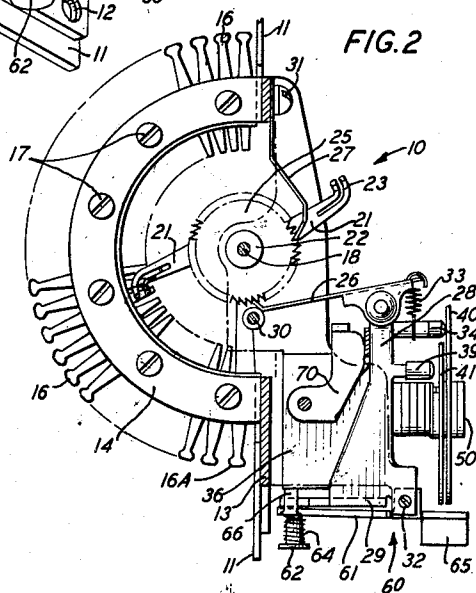


FIG. 2



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COUNTERBALANCE ASSEMBLY

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The present invention relates to automatic switches and more particularly to counterbalances which prevent false operation of automatic stepping switches under vibration or shock.

Automatic stepping switches are suitable for use in telephone or like systems in which signals are sent by means of trains of electrical impulses which serve to bring about step-by-step operation of the switch. Under control of impulsing devices the stepping switches may perform operations of selection, sequence control, counting and totalizing. Briefly, the stepping switch has a semicylindrical bank of contacts over which a set of wipers is stepped by means of a pawl and ratchet mechanism. The pawl and ratchet mechanism is actuated by an armature responsive to momentary impulses of current through an electromagnet associated with the armature. The movement of the armature causes the pawl to engage the next ratchet tooth and also causes the deflection of a driving spring. Deenergization of the electromagnet at the end of each impulse allows the driving spring to restore, returning the armature to its original position. The armature forces the pawl against the ratchet tooth to rotate the ratchet and the set of wipers therewith to make contact with the next set of bank contacts.

To prevent false operation of the switch when it is accelerated or under shock it is necessary to restrict the movement of the armature when there is no change of coil energization, and yet permit positive movement of the armature when there is a change in energization. Heretofore in the prior art various counterbalance arrangements were provided to prevent false operation of switches. The problem however of preventing false operation under shock is coupled with the problem of maintaining the fast operation of the switch.

It is then an object of the present invention to provide for a novel counterbalance structure that prevents false operation of an automatic stepping switch while maintaining its operating speed.

In the specific embodiment employed herein this object is accomplished by providing an armature and a separate counterbalance assembly. The armature and counterbalance assembly are pivoted on the same shaft and resiliently connected to each other. A linear acceleration tending to cause false operation of the switch causes the armature and counterbalance assembly to rotate in opposite directions. The rotated counterbalance assembly bears against a shouldered pin in the resilient coupling between the counterbalance assembly and the armature and prevents the movement of the armature. The counterbalance assembly in this manner offsets the effect of the linear acceleration upon the armature. Since the counterbalance assembly is detached from the armature, the mass of the armature remains the same and the speed of operation is maintained.

It is then another object of the present invention to provide for a counterbalance assembly that is effective

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to control the movement of a specific armature of an automatic stepping switch under linear acceleration.

A feature of the present invention is the provision of a shockproof stepping switch having a counterbalanced armature whereby the counterbalancing is effected without adding to the mass of the armature.

Further objects, features and advantages will become apparent to those skilled in the art upon consideration of the following description taken in conjunction with the drawings wherein:

Fig. 1 is a pictorial view of the automatic stepping switch of the present invention;

Fig. 2 is an elevation view with part of the main frame removed; and

Fig. 3 is an exploded view of the counterbalance assembly and armature of the present invention.

Referring to Figs. 1 and 2, the stepping switch 10 is mounted utilizing the holes 12 in mounting plates 11. The plates 11 are part of the bank frame 9 which also includes the arcuate binding members 14 which connect and are integral with the plates 11. The binding members 14 clamp and support a number of rows or bank levels of terminals or contacts 16 by means of the clamping screws 17. Each bank level of contacts 16 is constructed as a unit with the contacts 16 suitably insulated from each other. In the specific embodiment disclosed herein ten bank levels are provided which are suitably insulated from each other.

The bank frame 9 supports the main frame 13 at the bank adjusting lock screw 15 and two screws, not shown, which pass through the holes 12 in the lower plate 11 and assist in mounting the stepping switch 10. The main frame 13 supports the remaining components of switch 10 as is hereinafter described.

The main frame 13 supports a stationary shaft 18 which is held in place by a locking plate 19 and screw 20. The shaft 18 supports a wiper assembly which comprises ten pairs of wipers 21, insulation spacers, not shown, therebetween and a number wheel, also not shown, mounted on a molded phenolic sleeve 22. One pair of wipers 21 contacts each bank level of terminals 16. The tip 23 of each wiper 21 is split to provide for two contacting surfaces and insure against contact failure. As the wipers 21 contact terminals 16 the hub portion of the wipers 21 contacts brushes 24 which are connected to the brush spring terminal 16A. A conductive path is in this manner provided from terminals 16A, through brushes 24, wipers 21 and the ten terminals 16 corresponding to one of the twenty-six stepping positions of the stepping switch 10.

The shaft 18 also supports a fifty-two-toothed ratchet 25 through which the wiper assembly is driven. The ratchet 25 is engaged by a driving pawl 26 and a holding pawl 27. The driving pawl 26 is pivoted upon the arm 28 of armature 29 and is limited in movement by the adjustable backstop 30. The adjustable pawl backstop 30, supported on the main frame 13, prevents the wiper assembly from overthrowing on each step. The holding pawl 27 is mounted upon the main frame 13 by means of the detent spring screw 31.

The armature 29 is supported on a stationary shaft 32 which is in turn supported by the main frame 13 and retained immovable by the locking member 48 and screw 49. When the armature 29 is rotated about pivot pin 32 in a clockwise manner, the driving pawl 26 is rotated in a counterclockwise manner against the restoring force of a spring 33. The spring 33 is connected to a bushing 34, which is mounted on arm 28, and maintains the pawl 26 against ratchet 25. The rotation of pawl 26 moves it out of engagement with one tooth on ratchet 25 and into engagement with the adjacent tooth. The ratchet

25, held in position by pawl 27, does not rotate when the armature 29 is rotated in a clockwise manner.

When the armature 29 releases or rotates in a counterclockwise direction, the pawl 26 is forced against the ratchet 25 causing it to rotate in a clockwise direction with pawl 27 slipping to the next tooth. The stroke of the armature 29 is adjusted by means of two coil frame adjusting screws 35 which support a coil frame 36 in the main frame 13. The coil frame 36 supports the coil 37 which controls the operation or movement of armature 29. The magnetic circuit through the coil 37, coil frame 36 and armature 29 is highly efficient to provide for high speed operation of the stepping switch 10.

The arm 28 of armature 29 carries the bushing 34 described above and also a bushing 39. The bushing 34 bears against the main or driving spring 40 which restores the armature 29 when coil 37 deenergizes and bushing 39 actuates interrupter springs 41 when the coil 37 is energized. The other arm 42 of armature 29 carries a bushing 43 for actuating a set of auxiliary contact springs 44. Terminals 45 are connected to the springs 40 and 41 and are supported therewith by supports 50 and screws 51 upon the coil frame 36.

For remote-controlled operation by a series of impulses, duration of an impulse to coil 37 must be sufficient to cause the armature 29 to operate and the time between impulses must be sufficient to allow it to restore. For the standard telephone dialing rate of ten pulses per second at 48 volts, the closed circuit period or percent make must be between 16½ percent and 94 percent of the impulse cycle. The greater the impulse rate the narrower the range of percent make that is permissible. The operating rate therefor of switch 10 is an important factor in its utility as a stepping switch. This rate is governed to a great extent by the inertia of armature 29 which is, of course, dependent upon its mass. The necessity of maintaining fast operation is complicated by the requirement of preventing false operation of the switch 10 when it is subjected to shock or vibration. The requirement for preventing false operation can be effected by counterbalancing armature 29. Such a solution however by adding mass to the armature 29 slows down the operating speed of the stepping switch 10.

In the specific embodiment incorporated herein, both requirements are met by providing for a separate counterbalance assembly 60 as shown in Figs. 1 through 3.

The counterbalance assembly 60 comprises a non-magnetic sheet metal bracket or counterbalance member 61 pivoted on shaft 32 with no direct coupling or connection to armature 29. The armature 29 carries a shouldered pin 62 rigidly attached thereto which passes through the opening 63 in counterbalance member 61. The pin 61 supports a coiled spring 64 against the member 61 so that when the armature 29 and member 61 separate the spring 64 is compressed. The member or bracket 61 supports a small steel weight 65 approximately ⅝ inch by ½ inch by 1 inch attached at one end which extends approximately ¾ of an inch from the ¼ of an inch shaft 32. The clockwise rotation or motion of the bracket 61 is limited by two formed legs 66 which rest upon the coil frame 36. During normal operation the coil spring 64 permits free operation of the armature 29 and also prevents undesirable motion of the counterbalance assembly 60.

A linear acceleration of the stepping switch 10 will cause the armature 29 and counterbalance member 61 to rotate in opposite directions as their centers of gravity occur on opposite sides of the shaft 32 which is the common pivot point.

As described above when the coil 37 is not energized, the armature 29 is at its counterclockwise or lower position as shown in Figs. 1 through 3. If a shock occurs when the coil 37 is not energized, the pawl 26, as is hereinafter described, will not move sufficiently to en-

gage the next tooth of the ratchet 25. If the shock or linear acceleration is from below, the armature 29 will tend to rotate in a counterclockwise direction and the counterbalance member 61 will tend to rotate in a clockwise direction. Due to the legs 66 described above the counterbalance member 61 cannot so rotate. The arm 28 of armature 29 bears against the backstop 70 which is also supported by the screw 49 described above. The armature 29 therefore cannot rotate in a counterclockwise direction under shock from below when the coil 37 is not energized. The counterbalance member 61 is in this manner, in effect, not utilized when the armature 29 tends to rotate in a counterclockwise direction to provide for substantially a one-way coupling which is operative when the armature tends to rotate in a clockwise direction. If the shock or acceleration is from above, the armature 29 will tend to rotate in a clockwise direction to cause the pawl 28 to rotate the ratchet 25 and the counterbalance member 61 will tend to rotate in a counterclockwise direction. Due to their respective moments of inertia the movement of the counterbalance member 61 will precede the movement of the armature 29. As the counterbalance member 61 rotates in a counterclockwise direction under the acceleration from above, it compresses the coil spring 64 against the shouldered pin 62. The compression of the coil spring 64 causes it to exert a force upon the armature 29 through the shouldered pin 62 tending to cause the armature 29 to rotate in a counterclockwise direction with the counterbalance member 61. The tendency therefore of the armature 29 to rotate in a clockwise direction under shock is counteracted by the force supplied by the counterbalance member 61 on the shouldered pin 62. The speed of operation or movement of the armature 29 is not inhibited by the use of such a counterbalance assembly 60 and false operation under shock is in this manner prevented.

When the coil 37 is energized the armature 29 is maintained in its clockwise or top position against the coil 37 with sufficient attraction to prevent disturbance during shock. Moreover a linear shock during the time that the coil 37 is being energized or deenergized will not disturb the stepping operation. A specific armature 29 is, in this manner, operated to step the ratchet 25 without disturbance and without diminishing its speed of operation in the presence of shock or acceleration.

It is to be understood that the above-described arrangements are illustrative of the application of the principles of this invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. An automatic stepping switch comprising a coil frame; a pivoted armature mounted upon said coil frame having a pivot point and a center of gravity located at one side of said point; and a counterbalance assembly mounted upon said point having its center of gravity located at the other side of said point whereby said armature and said assembly tend to rotate in opposite directions under linear acceleration, said assembly having a resilient coupling connecting said assembly with said armature.

2. An automatic stepping switch in accordance with claim 1 wherein said assembly comprises in addition a bracket and said resilient coupling comprises a shouldered coupling pin rigidly connected to said armature and passing through said bracket, and a coil spring supported between said shouldered coupling pin and said bracket.

3. An automatic stepping switch in accordance with claim 1 comprising in addition a common pivot pin for said armature and said assembly.

4. An automatic stepping switch in accordance with claim 2 wherein said coupling pin is connected to said armature on the same side of said coil frame as the center of gravity of said armature is located.

5. An automatic stepping switch in accordance with claim 3 wherein said coupling pin is connected to said

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armature on the same side of said coil frame as the center of gravity of said armature is located.

6. An automatic stepping switch in accordance with claim 4 comprising in addition stops limiting the movement of said armature and assembly towards each other.

7. A counterbalance assembly for spring driven stepping switches comprising a pivot pin; an armature pivoted on said pin; and a separate counterbalance member pivoted on said pivot pin and resiliently connected to said armature having a moment of inertia smaller than the moment of inertia of said armature.

8. An automatic stepping switch comprising a coil frame; an armature mounted upon said coil frame having its center of gravity located at one side of said coil frame; and a counterbalance assembly mounted upon said coil frame having its center of gravity located at the other side of said coil frame whereby said armature and said assembly tend to rotate in opposite directions under linear acceleration and having a moment of

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inertia smaller than the moment of inertia of said armature, said assembly comprising a resilient coupling connecting said assembly with said armature.

9. A counterbalance assembly for spring driven stepping switches comprising a pivot pin; an armature pivoted on said pin; a separate counterbalance member pivoted on said pin having a moment of inertia smaller than the moment of inertia of said armature; and a one-way coupling connecting said member with said armature.

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