April 22, 1969 W. GERSPACH 3,440,582

STEP-BY-STEP SWITCH

Filed Sept. 14, 1966

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FIG. 1.

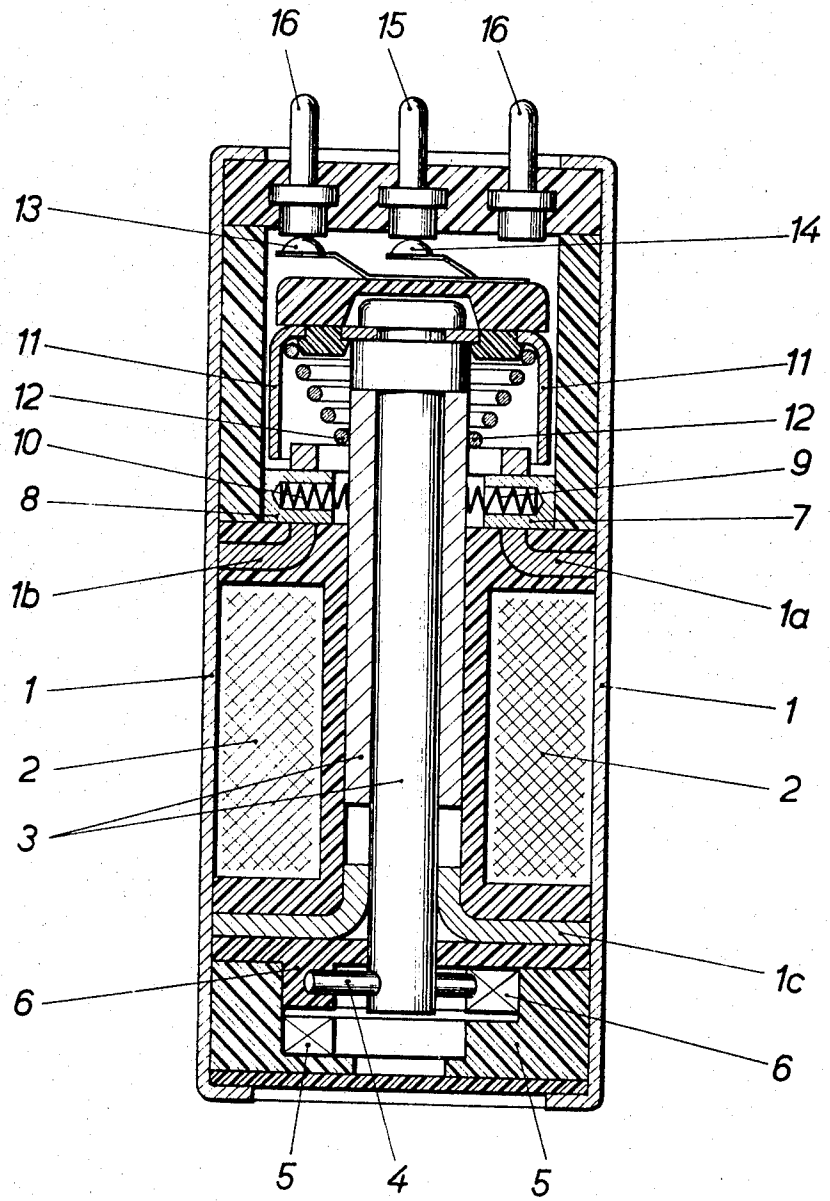

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FIG. 2.

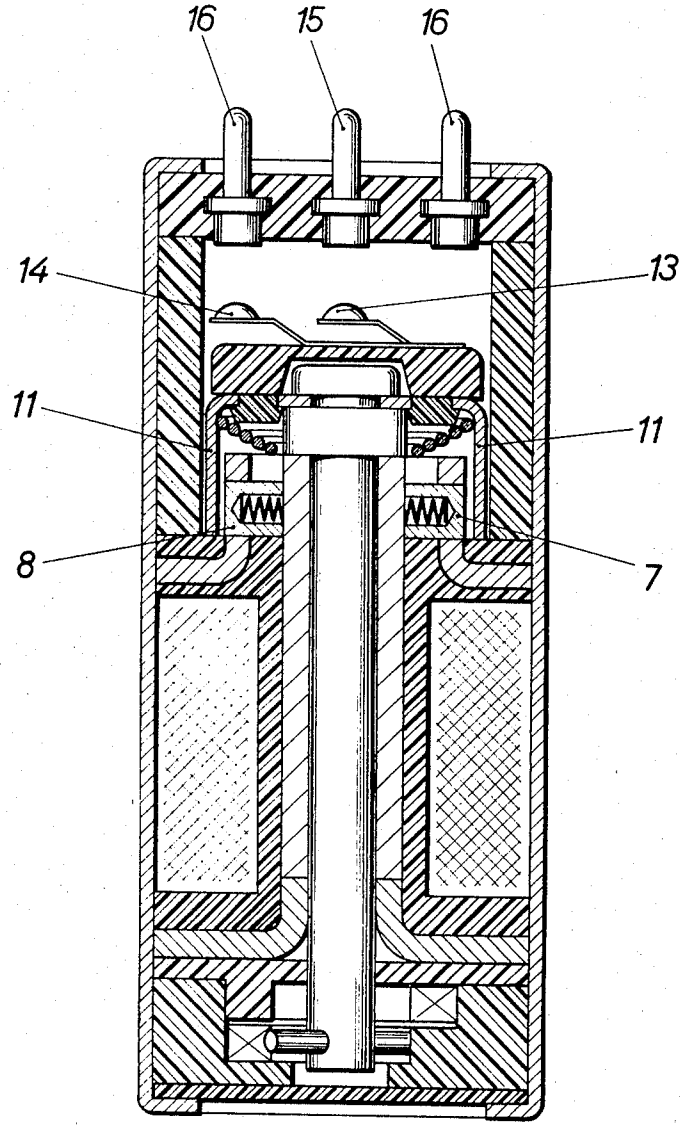

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FIG.3.

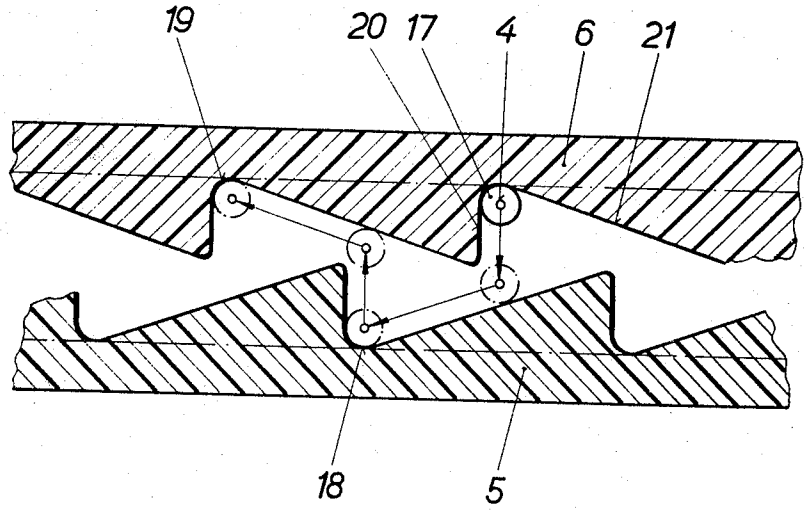
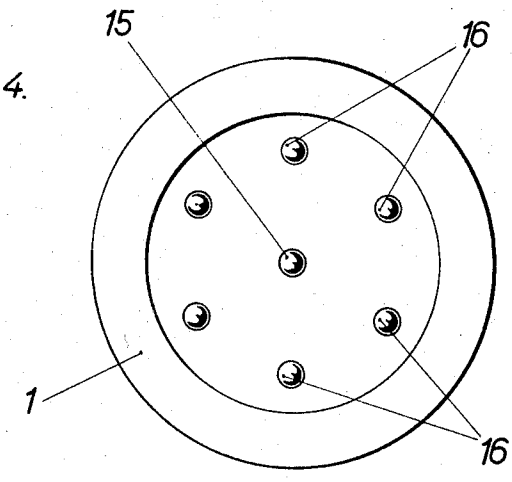


FIG.4.



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3,440,582

STEP-BY-STEP SWITCH

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6 Claims

ABSTRACT OF THE DISCLOSURE

A magnetically operated stepping switch wherein the switching member comprises a turnable spring-biased solenoid core arranged for both rotary and axial movement. The core has a radial pin alternately engagebale with opposed cam teeth to effect its rotary movement as it is axially reciprocated by energization and deenergization of the solenoid. Magnetic blocking members normally block the core against axial movement, and are shifted to unblock the core by the flux of the solenoid.

This invention relates to step-by-step switches based on the plunger armature principle, in which the switch drive utilises the tractive power of a plunger armature in a magnet coil through which current passes, and in which the switch movement is effected by means of a pin which is firmly inserted radially in the extended plunger armature and the axial movement of the plunger armature is limited by two crown ratchet wheels, the common axis of which is constituted by the plunger armature. In this type of switching drive the pin is pulled out of the button of the tooth of the first ratchet wheel by the traction of the plunger armature and comes to bear against the opposite tooth flank of the second ratchet wheel, on which it slides away in a rotary movement. After collapse of the magnetic field the pin drops back into the next tooth bottom of the rest ratchet wheel and thereby performs a complete switching step which is equivalent to an angular movement corresponding to the tooth pitch.

In known step-by-step switches of this type, external forces producing mechanical accelerations in the axial direction or accelerations having components in that direction undesirably produce a step movement.

An object of the present invention is to achieve the effect that mechanical accelerations due to external forces on the step-by-step switch in any direction cannot give rise to a movement step. On termination of the action of such an acceleration the conditon of the switch which previously existed remains in effect. By means of the invention this is achieved by a blocking device, through the fact that additional magnetic locking means are disposed in the magnetic flux path of the plunger armature magnet, in such a manner that on the commencement of the build-up of the magnetic field for the plunger armature they are drawn out of the path of movement of the plunger armature or out of the path of movement of locking elements joined to the plunger armature before, on the further build-up of the magnetic field, the plunger armature itself is attracted.

If the step-by-step switch according to the invention is not energized magnetically but simply accelerated mechanically, as by external forces with a component in the axial direction, the plunger armature is held locked against axial movement and thus cannot advance the step-by-step switch.

One embodiment of the invention will now be explained in greater detail, with reference to the accompanying drawings, in which:

FIGURE 1 illustrates the construction of a step-by-step switch in the position of rest;

FIGURE 2 illustrates the switch with the plunger armature attracted; and

FIGURE 3 illustrates two toothed end face parts which are disposed opposite but offset in relation to one another. In the toothing illustrated, for the sake of simplicity the opposite toothing is not shown as a pair of teeth;

FIGURE 4 illustrates the switch in a view from above.

Referring to the drawings a step-by-step switch consists of an iron magnet shell 1, a coil 2, a plunger armature 3, a cross-pin 4, and two end face crown toothings or gear wheels 5 and 6. In accordance with this invention I provide an improved armature blocking means which is automatically releasable, comprising slide bolts in the form of locking magnet pieces 7 and 8 with restoring springs 9 and 10, and a locking pot or cup 11 with a restoring spring 12. The stepping switch further comprises contact springs 13 and 14 which are movable with the plunger 3, and a stationary supply contact pin 15, with a stationary separate output contact pin 16 for each step.

When current is applied to the coil 2, it builds up around it a magnetic field through the magnetic circuit which includes the iron magnet shell 1 and also the flux conducting mountings 1*a*, 1*b* which constitute slide bearings for the locking magnet pieces 7, 8, as well as the lower annular pole piece 1*c* which field first attracts the locking magnet pieces 7 and 8 toward the plunger armature 3. As the magnetic field becomes stronger, the plunger armature 3 experiences its operational movement and is drawn downward into the coil 2. Since, according to the invention, the locking magnet pieces 7 and 8 have been drawn inward and away from the sliding region of the locking pot 11, the latter can allow the downward movement of the plunger armature and thus the cross-pin 4 strikes against the corresponding tooth pair of the crown toothing 5 (FIGURES 2 and 3). Through the force applied the cross-pin moves out of position 17 of the crown toothing 6 which is illustrated in FIGURE 3 and into the position 18 of the crown toothing 5, so that the plunger armature turns by half a tooth.

In FIGURE 2 this attracted condition of the step-by-step switch is illustrated. When the coil 2 is now deprived of current, the plunger armature drops back into its position of rest under the action of the restoring spring 12. The cross-pin thus passes from position 18 (FIGURE 3) of the crown toothing 5 to position 19 of the crown toothing 6. The plunger armature has thus performed the second half of the rotary step by sliding on the tooth flank. The two locking magnet pieces 7 and 8 are brought again into the starting position by the action of the springs 9 and 10.

Through the above cycle the supply contact pin 15 (FIGURE 1) has now been connected through the two contact springs 13 and 14 to the next contact pin 16 which follows by one step the previously connected contact pin 16.

Through further electric impulses the step-by-step switch can be moved on one step at a time.

If a previously adjusted step-by-step switch of the present type is exposed only to a mechanical acceleration as from external forces, the contact springs 13, 14 cannot be advanced, because the two locking magnet pieces 7 and 8 lie in the sliding region of the locking pot 11 and thus block and prevent the plunger armature 3 from moving downward into the coil 2, so that the cross-pin 4 remains locked between the tooth breast 20 and the tooth flank 21 (FIGURE 3) which prevent rotation of the plunger armature and therefore of the contact springs

13 and 14. On termination of the action of any mechanical acceleration having axial components, even if the contact springs 13 and 14 have during such acceleration been lifted off the contact pins 15 and 16 of the previously adjusted step, said springs will again bear against these contact pins so that a perfect contact is ensured. If it is desired to ensure that the constacts 15, 14: 13, 16 will not be opened even under the action of an axial acceleration, the contact springs 13 and 14 have simply to be constructed with a larger spring path than the free axial movement play of the plunger armature 3 in relation to the locking magnet pieces 7 and 8.

This free movement play or lost motion of the plunger armature 3 can for example be seen in FIGURE 1 as the distance between the bottom edge of the locking pot 11 and the locking magnet pieces 7 and 8.

The mechanical locking between the locking magnet pieces and the locking pot may be constructed differently from the construction described above. It is however essential that through the build-up of the magnetic field for the plunger armature the mechanical locking should be released.

I claim:

1. A shock and acceleration resistant electrically-operated electric stepping switch comprising, in combination:

(a) a driving magnet coil,

(b) a plunger armature acted on by flux from said coil and movable between a first, non-attracted position and a second, attracted position,

(c) a cross pin affixed to the armature,

(d) armature drive means comprising opposed sets of cam teeth alternately engageable by said cross pin as the armature is moved between said first and second positions, for effecting a stepped rotary movement of the armature, and

(e) automatic, movable, magnetic flux-responsive blocking means normally preventing the armature from moving from said first position to said second position, said blocking means automatically shifting in response to flux from said magnet coil, when the latter is energized, to unblock the armature prior to operational movement of the armature in response to said flux.

2. The invention as in claim 1, wherein the blocking means comprises:

(a) a cup affixed to the armature and movable axially therewith,

(b) magnet pieces movable toward and away from the armature and attracted toward the latter by magnetism thereof,

(c) spring means urging the said pieces away from the armatures and into the path of movement of said cup,

(d) said magnetism overcoming the spring means and shifting the magnet pieces out of said path of movement.

3. The invention as in claim 2, wherein:

(a) at least two, oppositely disposed magnet pieces are provided, cooperable with said cup.

4. The invention as in claim 2, wherein:

(a) the blocking means further includes flux-conducting slide bearings carrying said magnet pieces and connected to the magnetic circuit for the magnet coil.

5. The invention as in claim 4, wherein:

(a) said magnet pieces comprise slide bolts movable in radial direction with respect to said armature.

6. The invention as in claim 1, wherein:

(a) the armature has some lost motion between its first position and its blocked position,

(b) said armature carrying contact springs,

(c) fixed contacts cooperable with said contact springs and engageable therewith when the armature is in said first position,

(d) said springs having an inherent path of spring movement which is greater than said lost motion movement of the armature, and being so constituted that they normally remain in contact with said fixed contacts at all times that the armature remains blocked or in its first position.

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U.S. Cl. X.R.

335—174