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2,531,882

ELECTROMAGNETIC STEP-BY-STEP SWITCH

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2 Sheets-Sheet 1

Fig. 1.

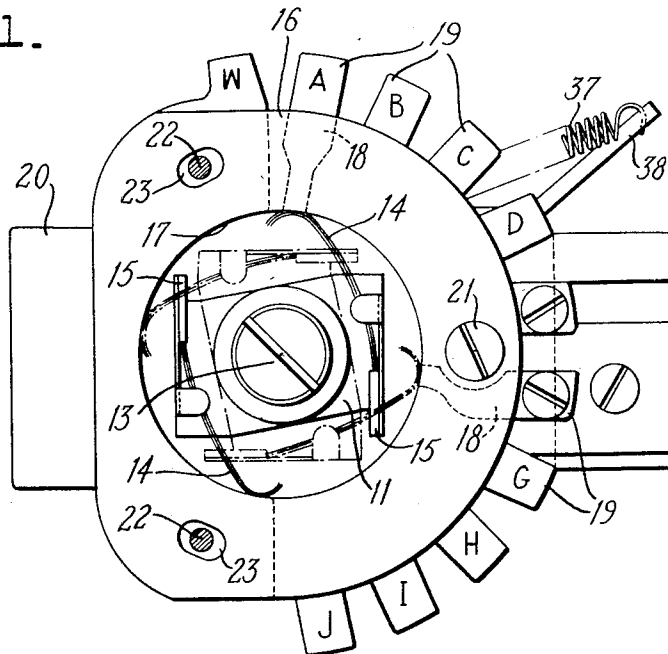
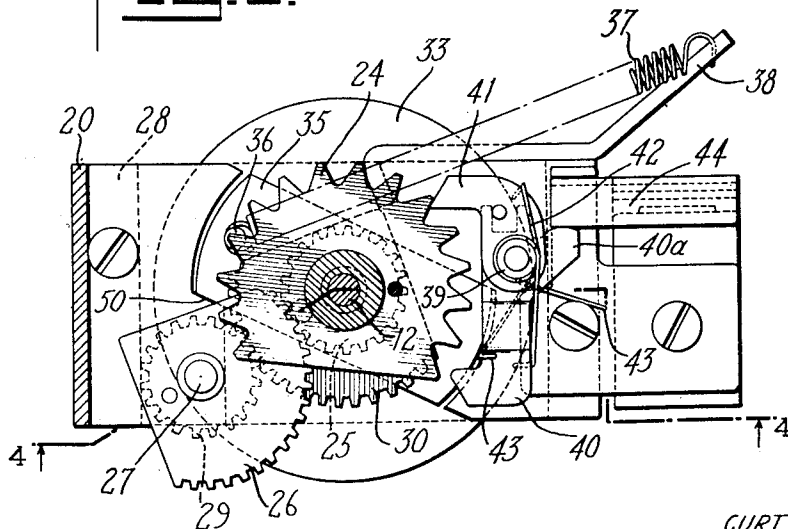


Fig. 2.



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Fig. 3.

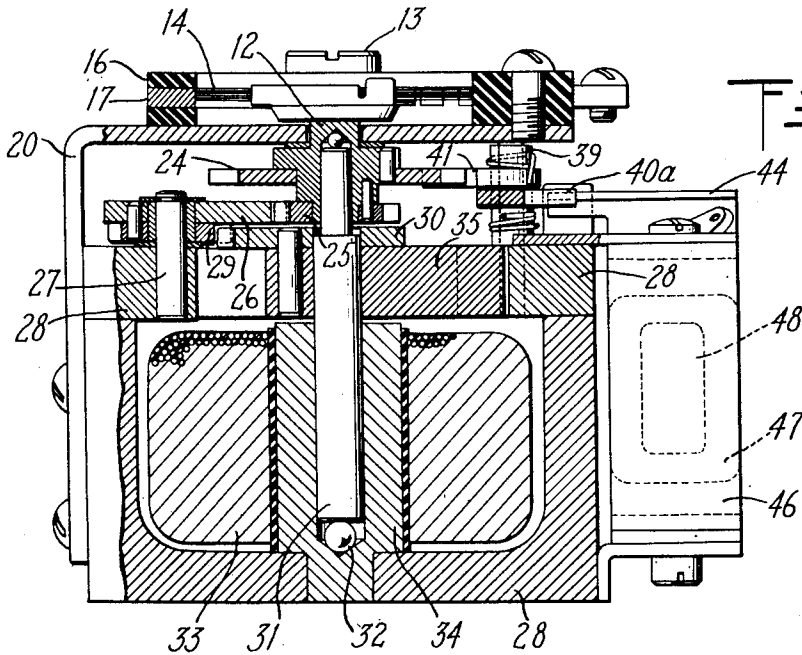
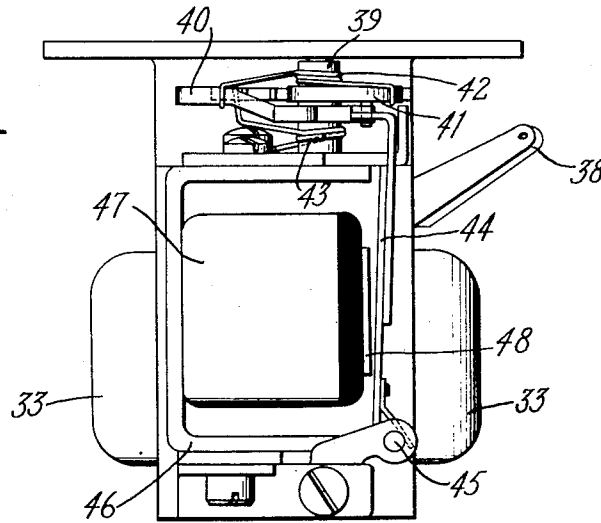


Fig. 4.

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ELECTROMAGNETIC STEP-BY-STEP SWITCH

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2 Claims. (Cl. 200—105)

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This invention relates to devices whereby a series of electrical circuits may be established in single step increments under actuation of an electrical impulse delivered from a remote point.

More specifically this invention relates to selective switches or relays, particularly to stepping relays capable of functioning as impulse accumulators, distributors or counters wherein the required actuating impulse is of short duration and uses a minimum expenditure of electrical energy.

Stepping relays commonly are operated by a solenoid and linkage arrangement whereby a conductive arm is advanced by increments to contact successively a series of conducting points along a predetermined path. The energy required to move the conductive arm for each successive step is provided by the solenoids. An example of a stepping relay of this type is found in U. S. Patent 1,569,450. These devices consume a considerable amount of electrical energy which is provided by either a heavy current for a short duration or a lighter current for a longer duration. In some stepping relay applications neither of the aforementioned conditions can be tolerated without sacrificing efficiency.

In electrical accounting machines, for example, where stepping relays frequently are used as impulse accumulators it is essential to have high speed operation. Consequently, stepping relays have to be operated using a relatively heavy current for each incremental operation. Excessive wear is encountered frequently in the moving parts, and the current consumed by a plurality of such relays operating in parallel may be damaging to the devices initiating the actuating impulses. Constant operation at high speed in such machines results in further operational difficulties so that stepping relays have to be replaced frequently.

The present invention is concerned with improvements in stepping relays so that the difficulties mentioned above may be avoided. These improvements have become feasible by taking advantage of the characteristic cyclic operation of devices, such as electrical accounting machines, in which during one part of the operating cycle relays are conditioned to receive impulses while during another part of the operating cycle they may be insensitive.

It is, accordingly, an object of this invention to provide an improved stepping relay capable of high speed operation under actuation of an electrical impulse of short duration and small magnitude.

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It is a further object of this invention to provide an improved stepping relay in which the energy required for operation over a plurality of steps is stored at one time for release in incremental amounts by actuating impulses to cause operations at other times.

It is another object of this invention to provide a stepping relay of improved construction and arrangement of parts wherein the wear upon moving parts is reduced to a minimum.

It is still a further object of this invention to provide an improved stepping relay in which the actuating impulse for each incremental operation represents only a small percentage of the energy released at each operation.

Other objects of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawings, which disclose, by way of example, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

In the drawings:

Fig. 1 is a top view of the stepping relay showing the circuit establishing contacts and the distributing arm assemblies.

Fig. 2 is substantially the same as Fig. 1 with contact and distributing arm assemblies removed.

Fig. 3 is a partial side elevation view of Fig. 2 to illustrate details of the impulse actuating mechanism.

Fig. 4 is a sectional view of Fig. 2 along the line 4—4 to which has been added a corresponding sectional view of the contact and distributing arm assemblies to show the relationship of the various elements of the operating mechanism.

With reference to Fig. 1, a rotatable distributor arm 11 is mounted on a hollow shaft 12 (see Figs. 2 and 4) by means of a clamping screw 13. The arm 11 carries a pair of diametrically opposed brushes 14 retained to the arm by the brush holders 15. The brushes 14 ride on the inner perimeter of an insulated contact ring 16 to contact respectively, an inserted common conductive segment 17, occupying approximately 180 degrees of the contact ring 16, and any one of ten (10) inserted contacts 18 equally spaced about the remainder of the ring 16. A lug 19 is provided for each contact 18 so that circuit connections can be made. A lug 19 is provided for the common conductive segment 17 for the same purpose. The remainder of the mechanism, hereinafter described, operates in a manner to rotate the arm 11 so that the brushes 14 close a circuit selectively between the segment 17 and

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any one of the contacts 18 in step by step fashion according to electrical impulses received from a remote point thereby actuating the mechanism. For example, if the arm 11 is resting in its normal position so that one brush 14 contacts the common segment 17 and the other brush 14 contacts the contact 18 corresponding to the lug 19 marked "A" and two actuating impulses are delivered to the actuating mechanism, the arm 11 will rotate by increments in a clockwise direction successively contacting the contacts corresponding to lugs 19 marked "B" and "C" and will remain on the contact corresponding to the lug 19 marked "C" until additional actuating impulses are received by the mechanism which is also capable of returning the arm 11 to its normal position by reversibly rotating it in a counterclockwise direction according to other impulses received by the mechanism. The ring 18 is mounted to the frame 20 by means of a screw 21 and two aligning studs 22 which engage elongated holes 23 in the ring 18.

The remainder of the mechanism is illustrated principally in Fig. 2 and detailed in Figs. 3 and 4. A ratchet segment 24 is fastened to the hollow shaft 12 to which also is attached a gear 25 which in turn meshes with an idler gear segment 26 which is mounted on a shaft 27. The shaft 27 is fastened to a portion of the mounting 28 to which the frame 20, previously mentioned, is also attached. Also mounted on the shaft 27 is an idler gear 29 which is pinned to the gear segment 26. The gear 29 meshes with a gear segment 30 which is fastened to a shaft 31 coaxially aligned and partly contained within the hollow shaft 12 and supported by a bearing 32 in the mounting 28. The mounting serves also to act as a magnetic yoke for a coil 33 which is located within the mounting partially surrounding the shaft 31 which, together with a hollow core 34, provides the central core for the coil 33.

An armature 35 also is affixed to the shaft 31 and arranged so that when coil 33 is energized the shaft 31 will be rotated counterclockwise (as viewed in Fig. 2) as the armature 35 rotates to embrace the greatest amount of flux between the faces of the magnetic yoke represented by the mounting 28. A pin 36 is located in one lobe of the armature 35 to which one end of a spring 37 is fastened. The opposite end of the spring 37 is attached to a bracket 38 which in turn is mounted to the frame 20. When the armature 35 rotates counterclockwise the spring 37 is stretched so that a tensional force is set up in the spring 37, tending to rotate the armature in a clockwise direction. Since the gear segment 30 is fastened to the armature shaft (shaft 31) and is pinned to the armature 35 it follows that any tendency for rotation of the armature will be transmitted to the hollow shaft 12 via the gear train gear segment 30, idler gear 29, idler gear segment 26, and gear 25. Consequently, the shaft 12, and the gear 25, the ratchet segment 24 and the distributor arm 11, all attached thereto, will be rotated in the same direction as the armature 35. The gear ratios are selected so that for approximately 90 degrees of rotation of the armature 35, the shaft 12 and its aforementioned components will rotate 180 degrees.

Attached to the mounting 28 is a stud 39 which carries an escapement pawl 40 and a stop pawl 41 both of which are engageable with ratchet segment 24. Normally the stop pawl 41 engages the ratchet segment 24 under the urging of a spring 42 to prevent its rotation when the spring

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37 is in tension as a result of the action of the armature 35, previously described. The escapement pawl 40 normally is held free from the ratchet segment 24 by a spring 43. One end 40a of the pawl 40 engages with the free end of an armature 44 which is pivoted at its other end on a stud 45 in a sub frame 46 which is attached to the mounting 28. A coil 47 having a core 48 attached to the frame 46 is energized to move the armature 44 to the left (as viewed in Fig. 3 of the drawings).

The operation of the device is as follows: Assuming that the arm 11 is positioned as shown in Fig. 1 (solid lines) with the brushes 14 respectively resting on the conductive segment 17 and the contact 18 corresponding to the lug 19 marked "A," and that the armature 35 has been acted upon by the coil 33 to assume the position shown in Fig. 2 to cause the spring 37 to have tension tending to rotate the armature 35 clockwise an electrical impulse is delivered to the coil 47 from a remote point. The armature 44 will be attracted thereby engaging the end 40a of the escapement pawl 40 which will be rotated clockwise about the stud 39 against the tension of the spring 43 to engage its forked end with a pin in the stop pawl 41 to rotate it about the stud 39 also in a clockwise direction. The pawl 40 engages a tooth in the ratchet segment 24 as the stop pawl 41 is pulled free and the ratchet segment 24 rotates clockwise under the urging of the spring 37 acting on the armature 35 through the gear train previously discussed in detail. Following the impulse the armature 44 is restored to its normally open position so that the end 40a of the pawl 40 is no longer engaged and the stop pawl 41 engages the ratchet 24 at the tooth following the one it previously engaged as the pawl 40 returns to its normal position under the urging of the spring 43. The arm 11 will be rotated clockwise to advance the brushes 14 to contact, respectively, the segment 17 and a contact 18 corresponding to a lug 19 marked "B." When four (4) more impulses are received by coil 47 the action just described will be repeated for an equivalent number of times until after the fifth impulse the arm 11 and the brushes 14 will rest as shown by the dot-dash lines in Fig. 1 so that the brushes 14 contact respectively the segment 17 and the contact 18 corresponding to a lug 19 marked "F."

At such a time in the operative cycle of the apparatus, to which the present invention is applied, when the present device is no longer required to be sensitive to actuating impulses, an electrical impulse is delivered, to the coil 33. When coil 33 is energized the armature 35 is rotated counterclockwise, as previously explained, and the shaft 12, together with the ratchet 24 and the arm 11, is rotated similarly until the brushes 14 of the arm 11 return to their original positions as viewed in Fig. 1. A stop 50 (see Fig. 2) is provided so that the armature 35 does not overrun its initial position. The ratchet 24 retains the shaft 12 from rotating in a clockwise direction by virtue of the stop pawl 41 which is cammed out of the way by the ratchet teeth when the ratchet 24 rotates counterclockwise. The spring 37 is stretched to store up energy to repeat its operation thereby conditioning the device to respond to actuating impulses delivered to the coil 47 as originally.

It can be readily understood that neither the magnitude nor the duration of the actuating impulse delivered to the coil 47 need be large, since

the energy required to pull the armature 44 to trip the pawl 40 is obviously small in quantity compared to that required to rotate the arm 11 and the brushes 14, the latter energy being provided by spring 37 from energy stored when the spring is stretched by the armature 35. Consequently, the present invention provides a device in which energy stored prior to operation can be released in single increments to furnish high speed impulse operation.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to a preferred embodiment, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention. It is the intention, therefore, to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. A rotary selective switch including a series of fixed contacts spaced in an arcuate path and a movable contact operable to engage the said fixed contacts in a predetermined sequence, a rotary member for carrying the said movable contact, a spring normally biasing the said member to position the movable contact at one extremity of the said series of fixed contacts, an armature coaxing and rotating with the said member, an electromagnet adapted to set up magnetic flux in the said armature for rotating it and the said member against the bias of the said spring to move the said fixed contact to the other extremity of the said series each time the electromagnet is energized, and means for releasing the movable contact from the said other extremity under the influence of the said spring for step by step engagement with the said fixed contacts.

able contact from the said other extremity under the influence of the said spring for step by step engagement with the said fixed contacts.

2. A rotary selective switch including a series of fixed contacts spaced in an arcuate path and a movable contact operable to engage the said fixed contacts in a predetermined sequence, a rotary member for carrying the said movable contact, a spring normally biasing the said member to position the movable contact at one extremity of the said series of fixed contacts, means for rotating the said member consisting of a rotatable armature arranged coaxially with the said member and a field winding surrounding the said armature, the said field winding being adapted, upon being energized, to set up flux to rotate the said armature and the said member against the bias of the said spring to position the movable contact at the other extremity of the said series, and means for releasing the movable contact from the said other extremity under the influence of the said spring for step by step engagement with the said fixed contacts.

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