United States Patent

Heap

[15] **3,663,904**

[45] **May 16, 1972**

[54] ELECTRO-MECHANICAL CONTROL APPARATUS

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[73] Assignee: **Joseph Lucas Industries Limited,** Birmingham, England

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Dec. 18, 1969 Great Britain.....61,642/69

[52] **U.S. Cl.**.....**335/138,** 74/527

[51] **Int. Cl.**.....**H01h 51/10**

[58] **Field of Search**.....335/138, 139, 40, 120, 164, 335/169, 254, 177, 180; 236/76; 74/527, 533

[56] **References Cited**

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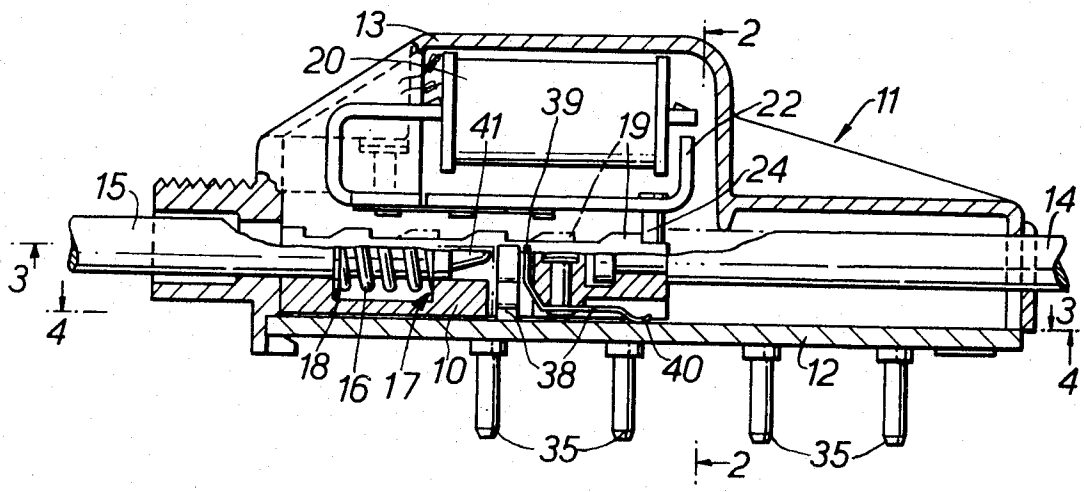
[57] **ABSTRACT**

An apparatus for providing step-by-step movement has a block which is urged by an external bias to slide within a body. The block has two rows of staggered projections which are respectively engageable by a pair of electromagnetically operated latches. The block co-operates with the body to provide a sequential switching arrangement for the latches alternately, whereby operation of one latch allows the block to move to a position at which the switching arrangement operates the next latch. Means is provided for over-riding the stepping action of the apparatus.

7 Claims, 10 Drawing Figures



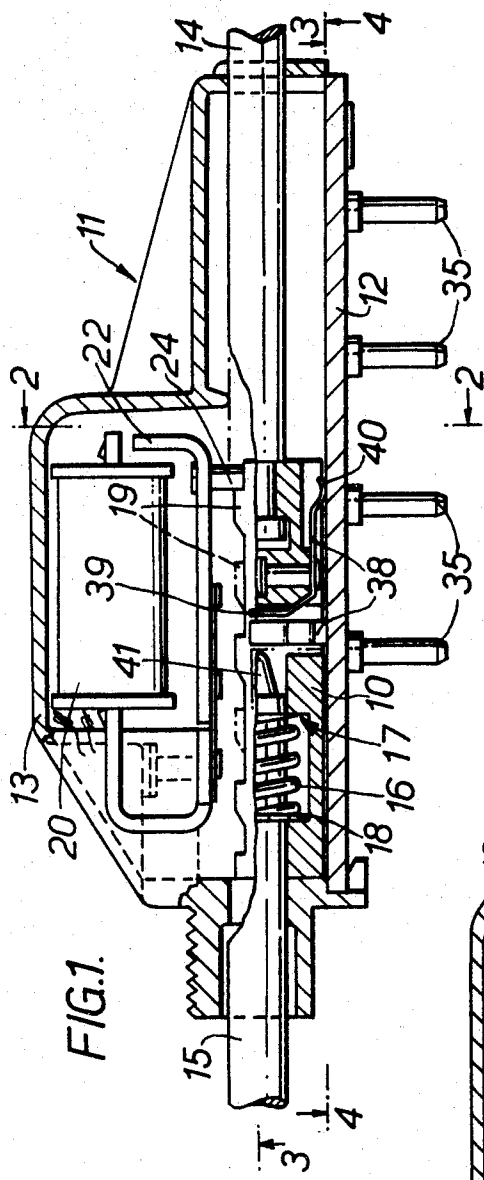


FIG.1.

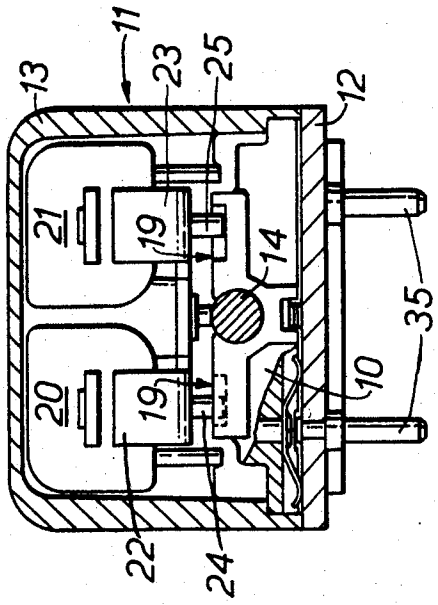


FIG.2.

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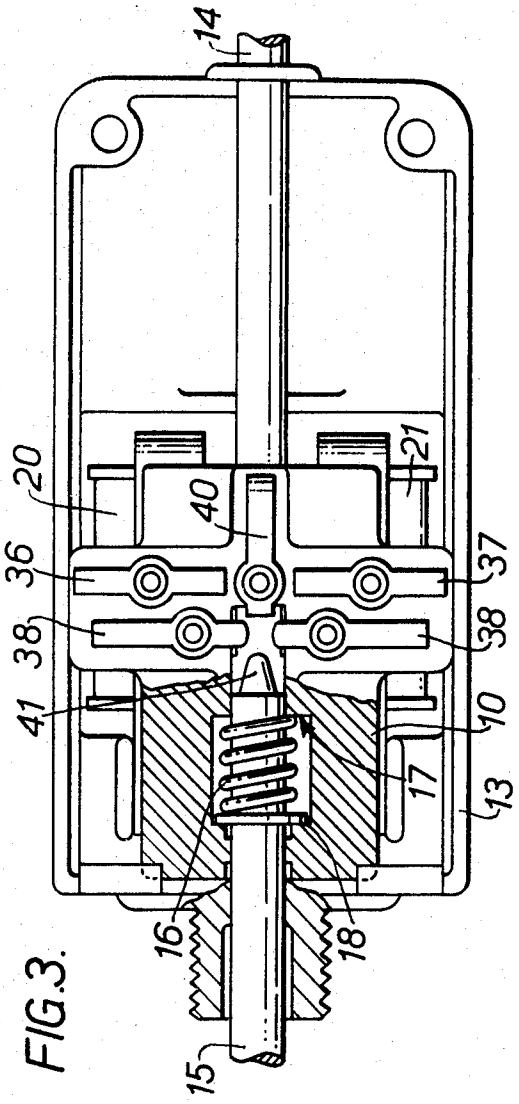

FIG.3.

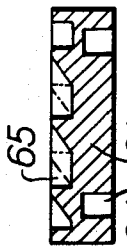

FIG.10.

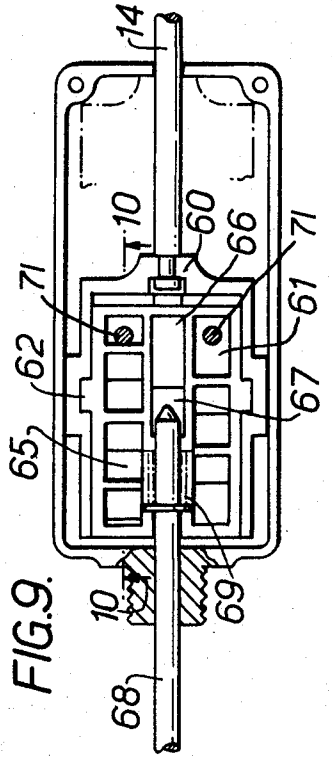

FIG.9.

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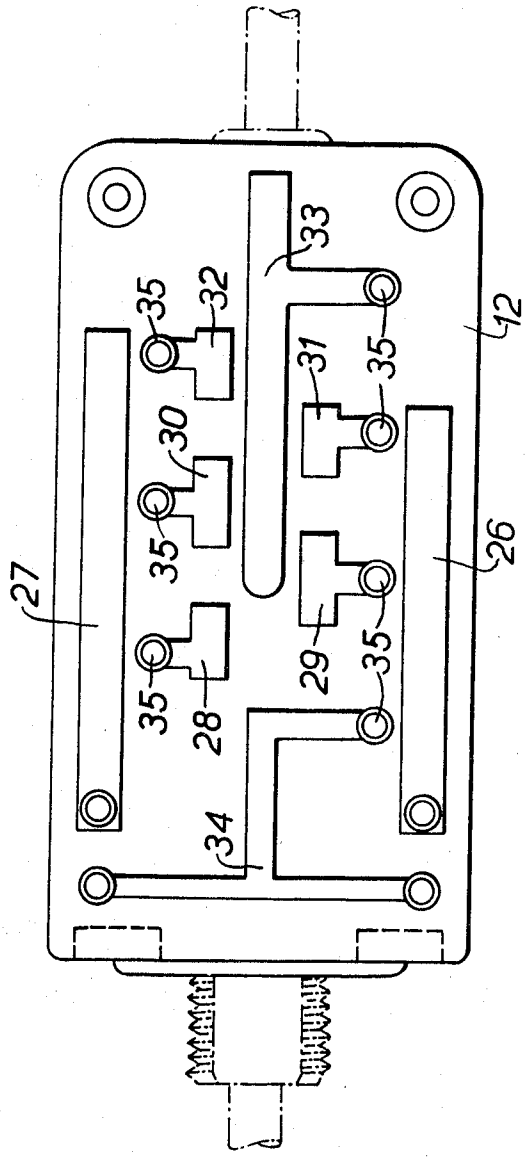
FIG.4.



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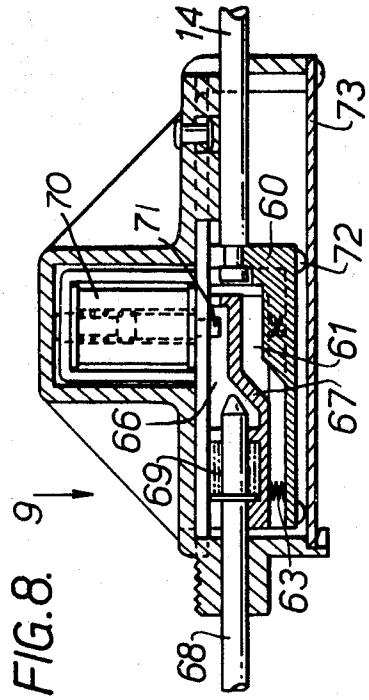

FIG. 8

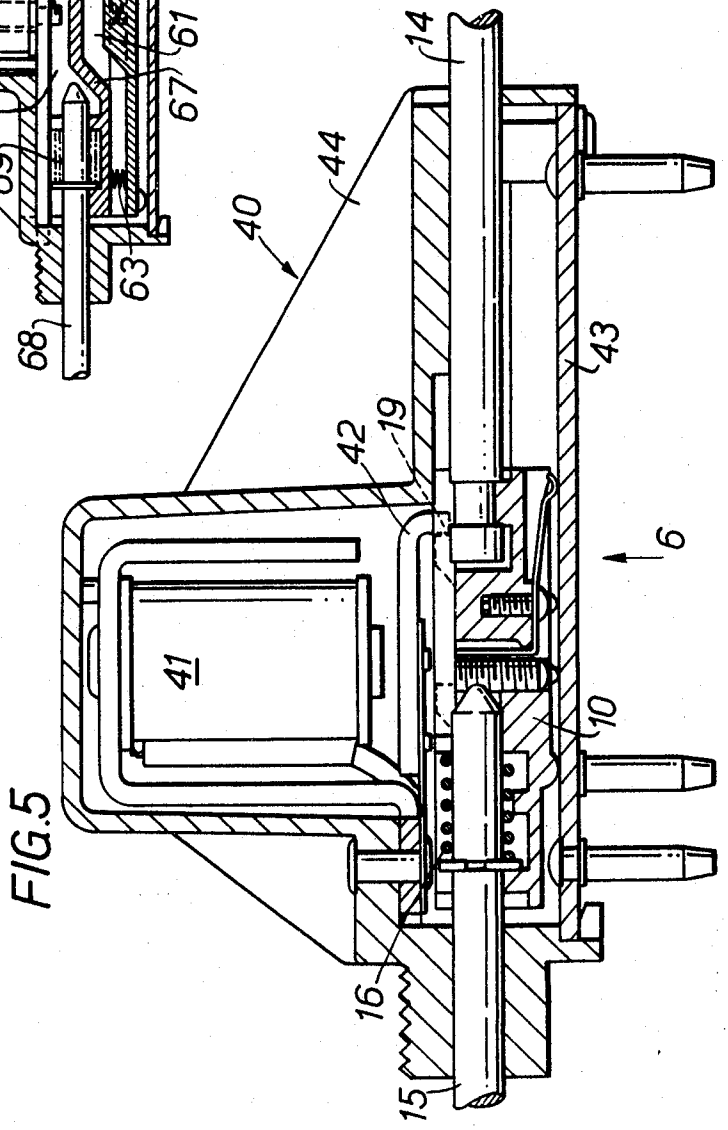

FIG. 5

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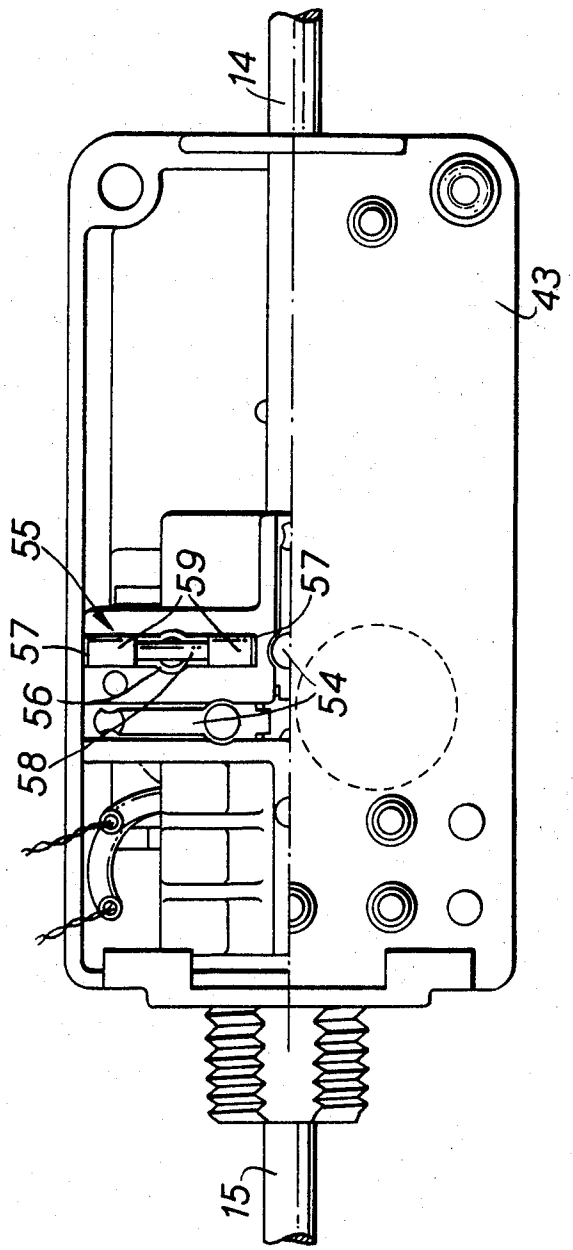

FIG.6.

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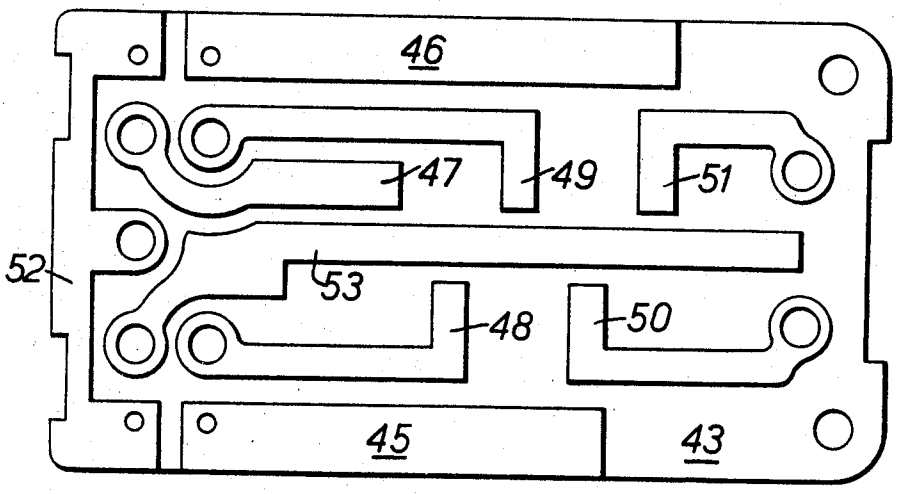
FIG. 7.



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ELECTRO-MECHANICAL CONTROL APPARATUS

This invention relates to an electro-mechanical control apparatus of a type from which a step-by-step movement is obtained in response to a sequence of electrical signals.

According to the invention a control apparatus of the foregoing type comprises a body, control means slidable in the body and having a series of projections thereon, a pair of electromagnets, a pair of latching members operable by the electromagnets respectively and engageable with the projections to provide a restraint for the control means, and switching means operable by the control means so as to render the electromagnets alternately energizable, the arrangement being such that, in the absence of any other restraint, movement of one latch member out of engagement with a projection permits the control means to move under the influence of a biasing force to a position in which the other latch member is engaged with a projection, whereby the control means is moved in a step-by-step manner.

Embodiments of the invention will now be described by way of example and with reference to the accompanying drawings in which:

FIG. 1 is a part section through a control apparatus,

FIGS. 2, 3 and 4 are sections on the corresponding lines in FIG. 1,

FIG. 5 is a part section through an alternative form of control apparatus,

FIG. 6 is a view, with parts removed for clarity, on arrow 6 in FIG. 5,

FIG. 7 is a view of a detail of the apparatus shown in FIG. 5,

FIG. 8 is a section through a further alternative form of apparatus,

FIG. 9 is a view, with parts removed for clarity, on arrow 9 in FIG. 8, and

FIG. 10 is a section on line 10—10 of a part of the apparatus.

Referring firstly to FIGS. 1 to 4, a control means in the form of a block 10 is slidable within a body 11 comprising a base 12 and a cover 13. A first stem 14 is supported in the body 11 and secured to the block 10. A second stem 15 is also supported by the body 11 and is slidable within the block 10. A compression spring 16 is engaged between a face 17 on the block 10 and a circlip 18 located on the stem 15.

The block 10 is formed with two parallel rows of projections 19, the projections in one row being in a staggered relationship with those in the other row, as shown in FIG. 1. A pair of electromagnets 20, 21 have associated spring-loaded armatures 22, 23 carrying latch members 24, 25 each of which is engageable with the projections 19 in a respective one of the rows. An external biasing means (not shown) urges the stem 14 to the right as shown in FIG. 1.

The base 12 is formed of a printed circuit board having formed thereon a pattern of conductors 26 to 34 inclusive as shown. Conductors 28 to 34 are each connected to a terminal 35 having a portion extending outwardly of the body 11. Electrical connections to the electromagnets 20, 21 are made respectively to conductors 26, 34 and 27, 34. Secured to the underside of the block 10 are a pair of identical resiliently deformable contact members 36, 37 respectively arranged to provide an electrical contact between conductors 26, 27 and their adjacent conductors 28 to 32 inclusive. Also secured to the underside of the block 10 are three identical resiliently deformable contact members 38, each having an upturned tongue 39 and a portion 40 in contact with a respective one of the conductors 26, 27, 33,. The stem 15 carries a metal ferrule 41 which may be urged into simultaneous contact with all the contact member 38 by movement of the stem 15 against the spring 16.

In use conductor 34 is connected, via its terminal 35, to an earth potential. Conductors 28 to 32 inclusive are connected, via their terminals 35, to voltage sources which are sequentially energized in accordance with an external operating condition, as for example a rise or fall in a pressure, temperature or voltage. Conductor 33 is connected, via its terminal 35, to a constantly energized voltage source. The stem 14 is coupled to an external apparatus (not shown) which includes an element whose linear movement is to be controlled, and which may also include the aforementioned biasing means for the stem 14.

Operation of the apparatus is initiated by moving the block 10 to the left, as seen in FIG. 1, by means of the stem 15, to a position in which the latch member 24 engages the projection 19 farthest from the stem 14. In this position contact member 36 provides a connection between the conductors 27, 28. A voltage applied to conductor 28 will thus energize the electromagnet 20 and permit the block 10 and stems 14, 15 to move until the latch member 25 engages the next adjacent projection 19 in the other row. In this position the contact member 37 engages the conductors 26, 29 permitting electromagnet 21 to be energized by application of a voltage to conductor 29. The circuit to electromagnet 20 is broken and the latch member returns to a position in which it is able to engage the next projection 19 in the associated row. Sequential application of voltages to the conductors 28 to 32 thus causes a stepping movement of the block 10 and stems 14, 15.

To over-ride the stepping movement of the apparatus, the stem is moved to compress the spring 16 and to bring the ferrule 41 into contact with the contact member 38, both electromagnets 20, 21 are simultaneously energized by the voltage on the conductor 33. The block 10 and stem 14 are thus urged by the stem and by the external biasing means to the full extent of their permitted movement.

An apparatus as described is particularly applicable to the control of a choke on an internal combustion engine, the full withdrawn position of the stem 15 corresponding to "maximum choke," and the sequential electrical signals being derived from the engine by means of switches which close at predetermined levels of temperature.

The alternative form of control apparatus shown in FIGS. 5 to 7 is generally the same as that shown and described with reference to FIGS. 1 and 4, and includes a block 10, first and second stems 14, 15 and a spring 16, as before. The block 10 and stems 14, 15 are slidable in a body 40 which supports a pair of electromagnets 41 which are in spaced parallel relation and whose axes are perpendicular to the axes of the stems 14, 15. The electromagnets 41 have spring-loaded armatures 42 which form latches engageable with projections 19 on the block 10.

The body 40 comprises a base 43 and a cover 44, the base 43 being a printed circuit board having a pattern of conductors 45 to 53 inclusive, as shown in FIG. 7. Connections are made to the respective electromagnets 41 between conductors 45, 52 and 46, 52. The block 10 carries three identical resiliently deformable contact members 54 which correspond to the contact member 38 in the first described embodiment and which engage the conductors 45, 46, 53. The block also carries a pair of contact assemblies 55 which respectively and sequentially provide an electrical contact between conductors 45, 46 and their adjacent conductors 47 to 51 inclusive. Each contact assembly 55 includes a resiliently deformable yoke 56 with a pair of parallel flanges 57. Rotatably mounted between the flanges 57 is a roller member 58 having portions 59 of increased diameter adjacent its ends. The portions 59 respectively engage the conductors 45, 46 and the conductors 47 to 51.

In use the apparatus operates as previously described, voltages being sequentially applied to the conductors 47 to 51. Movement of the stem 15 to compress the spring 16 causes the contacts 54 to be interconnected and both electromagnets 41 are energized to allow the block 10 to reach the full extent of its movement. The parallel portion of conductor 53 does not extend right to the end of the base 10. At the full extent of travel of the block 10, therefore, the contact 54 associated with the conductor 53 no longer engages that conductor. Thus, prolonged operation of the stem 15 to interconnect the contacts 54 does not result in prolonged flow of current to the electromagnets 41.

The further alternative form of apparatus shown in FIGS. **8** to **10** differs from the forms previously described in that the control means comprises a contact carrier **60** engaged with the stem **14** and an element **61** mounted within the carrier **60** for sliding movement in a direction perpendicular to the axis of the stem **14**. Element **61** is formed with a pair of projections **62** which engage corresponding grooves in the carrier **60** and is biased upwardly of the carrier **60**, as shown in FIG. **8**, by four compression springs **63** which engage bores **64**.

Element **61** has two parallel rows of staggered projections **65**, as previously described. Element **61** also has a central slot **66** formed with a ramp **67** adapted to be engaged by the generally conical end of stem **68**. Stem **68** is similar to the stem **15** previously described but does not include a conductive portion at its end. Stem **68** is biased away from engagement with the ramp **67** by a spring **69**. A pair of electromagnets **70** have axial armatures **71** which provide latching means for the projections **61** in the respective rows. Contacts **72** are engageable with suitable conductor patterns on a printed circuit board **73**.

Operation of the apparatus is substantially as previously described except that movement of the stem **68** to compress the spring **68** depresses the element **61** within the carrier **60** and disengages the projections **65** of both rows from the latching means. The stem **14** is thus enabled to move to the right under the influence of an external biasing means, as before.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. An electro-mechanical control apparatus for providing a step-by-step movement in response to a sequence of electrical signals, comprising a body, control means slidable in the body and having a series of projections thereon, a pair of electromagnets, a pair of latching members operable by the electromagnets respectively and engageable with the projections to provide a restraint for the control means, and switching means operable by the control means so as to render the electromagnets alternately energizable, the arrangement being such that, in the absence of any other restraint, movement of one latch member out of engagement with a projection permits the control means to move under the influence of a biasing force to a position in which the other latch member is engaged with a projection, whereby the control means is moved in a step-by-step manner.

2. An apparatus as claimed in claim **1** in which the projections are arranged in two substantially parallel rows, the projections in a row being in a staggered relationship with the projections in the other row.

3. An apparatus as claimed in claim **2** in which the switching means comprises an arrangement of conductors on the body and a plurality of contacts on the control means selectively engageable with the said conductors.

4. An apparatus as claimed in any preceding claim which includes over-ride means for disengaging both latching members simultaneously from the said projections.

5. An apparatus as claimed in claim **4** in which the over-ride means includes an actuating member operable to urge the control means in the direction of said step-by-step movement.

6. An apparatus as claimed in claim **5** in which the over-ride means includes further switch means for simultaneously energizing both electromagnets.

7. An apparatus as claimed in claim **5** in which the control means includes an element upon which said projections are formed and biasing means urging said element towards said latching members, the said element having a portion engageable by the actuating member so that operation of the latter urges said element away from engagement with said latch members.

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