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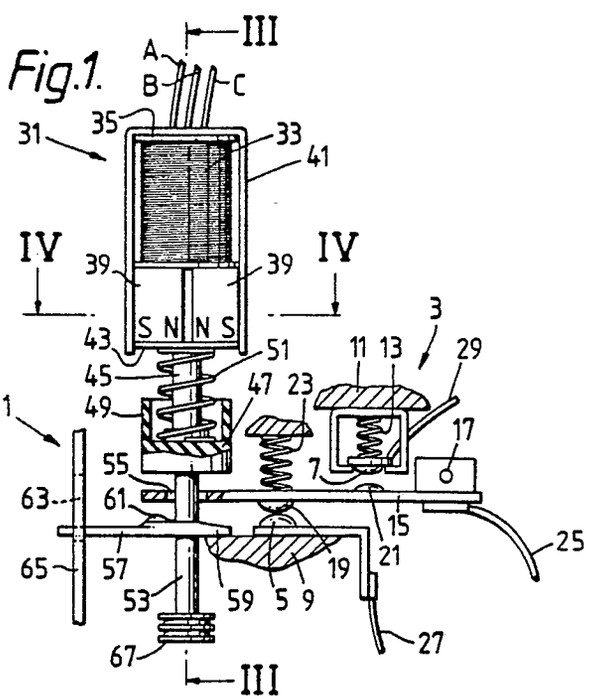
(54) Electric switches.

(57) An electric switch having a contact arm (15) mounted for movement about one end (17) whose contact (19) is disengaged from a fixed contact (5) of the switch by movement of the armature (45, 47) of an electromagnetic actuator (1). The actuator armature is arranged to contact the arm only after the armature has travelled some distance and thereby gained appreciable momentum, and the point of contact between the armature and contact arm is further from said one end of the arm than the contact on the arm, thereby more effectively to open the contacts in the event of any minor welding together of the contacts.

Fig.1.



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Electric Switches

This invention relates to electric switches.

More particularly the invention relates to electric switches of the kind comprising mechanical contacts and an electromagnetic actuator arranged to operate the contacts.

One problem which arises with such an electric switch when employed for switching relatively high currents is that the contacts tend to weld together. Whilst the use of a relatively high power actuator will ensure that the contacts will disengage despite a tendency to weld together, it is desirable to avoid the necessity for such a high power actuator if possible.

It is an object of the present invention to provide an electric switch wherein this problem is alleviated.

According to the present invention an electric switch comprises: a frame structure; a fixed contact rigidly located with respect to the frame structure; a moveable contact arm mounted for movement about one end and carrying at a first location along its length a contact arranged to engage and disengage said fixed contact on movement of said contact arm; and electromagnetic actuator means including an armature which moves between first and second positions in operation of the actuator means; the armature having a surface which is spaced from said contact arm when the armature is in its first position, thereby allowing the contact arm to take up a position in which said fixed and moveable contacts are engaged, which surface engages said contact arm at a second location on said arm only after said armature has passed an intermediate point along its path of travel from said first position to said second position, thereby to cause said contact arm to take up a pivotal position in which said fixed and moveable contacts are disengaged; said second location being further from said one end of said contact arm than said first location.

Preferably said moveable contact arm comprises a substantially rigid member pivotally mounted at said one end to said frame structure.

In one particular embodiment of the invention said actuator means incorporates permanent magnet means which serves to latch said armature in one of its positions, preferably its second position. In one such embodiment said actuator means further includes an electromagnet arranged for energisation selectively either to assist or oppose the attractive force exerted by said permanent magnet means on said armature. Said actuator means suitably also includes armature resilient means which urges the armature towards one of its positions. Where the actuator means includes permanent magnet means which serves to latch the armature in one of its positions said resilient means preferably urges said armature towards its position in which it is not latched.

Preferably the switch means also includes contact resilient means which serves to provide a positive contact pressure between said contacts when engaged. Where said actuator means includes permanent magnet means which serves to latch said armature in one of its positions, said contact resilient means preferably acts on said contact arm in such a direction as to tend to cause pivotal movement of said contact arm in the opposite direction to the direction of pivotal movement of said arm caused by movement of the armature to said one position from its other position.

One electric switch in accordance with the invention will now be described by way of example with reference to the accompanying drawings in which:-

Figure 1 is a diagram showing the switch when in one of two possible states;

Figure 2 is a diagram showing the switch in the other state; and

Figures 3 and 4 are diagrammatic sectional views of an electromagnetic actuator incorporated in the switch along lines III - III and IV - IV respectively in Figure 1.

Referring to the drawings, the switch comprises an electromagnetic actuator 1 which operates a switch contact unit 3.

The unit 3, which operates as a single pole two-way switch, comprises first and second fixed contacts 5 and 7 rigidly located with respect to respective parts 9 and 11 of the frame structure of the switch, e.g. parts of the casing of the switch, the contact 7 being spring loaded by means of a spring 13. The unit 3 further includes a rigid moveable contact arm 15 which at one end is pivoted to a part (not shown) of the switch frame structure by means of a pin 17. The arm 15 carries two moveable contacts 19 and 21 disposed on opposite sides of the arm 15, the arrangement being such that on clockwise rotation of the arm 15 on pin 17 the contact 21 engages fixed contact 7, and on anticlockwise rotation of the arm 15 the contact 19 engages fixed contact 5. A spring 23 acts on the arm 15 so as to tend to urge the contact 19 into engagement with the contact 5.

The arm 15 serves as a common electrical connection between contacts 19 and 21 and a first flexible lead 25 of the switch, the fixed contacts 5 and 7 being respectively provided with further leads 27 and 29.

The actuator 1 comprises a solenoid 31 comprising a two-winding coil 33 wound on a former 35 carried on a cylindrical pole piece 37, the pole piece 37 stopping short of one end of the former 35. The two windings each have one end connected to a common lead B and the other ends of the two windings are respectively connected to two leads A and C.

Adjacent one end of the solenoid 31 there are disposed two rectangular permanent magnets 39. The magnets 39 are arranged so that their inner surfaces define a cylindrical space coaxial with the solenoid pole piece 37, and each magnet 37 is magnetised to provide a north pole at its inner surface and a south pole at its outer surface. The solenoid 31 and magnets are enclosed within a steel frame 41, secured to the switch frame structure and are retained within the frame 41 by a non-magnetic closure member 43 and a tubular extension 35′ of the coil former which extends axially through the cylindrical space defined by the magnets 39.

The actuator 1 further includes an armature comprising a cylindrical steel plunger 45, part of which slides axially in the extension 35′ of the coil former, and a member 47 of insulating material secured to the end of the plunger 45 that projects beyond the magnets 39.

The member 47 has a flange portion 49 at its end adjacent the plunger 45 against which bears one end of a compression spring 51 positioned around the plunger 45 between the flange portion 49 and the closure member 43. On the side of the flange portion 49 remote from the plunger 45 the member 47 has a rod portion 53 which is coaxial with the plunger 45. The rod portion 53 extends through a slot 55 formed in the arm 15 and on the side of the arm 15 remote from the solenoid 31 has two projections 57 and 59 extending in opposite directions from the rod portion 53. One projection 57 has a lobe 61 arranged to engage the end of the arm 15 remote from the pivot pin 17 as further described below, and at its free end extends through a slot 63 formed through a part 65 of the switch casing, thereby to prevent rotary motion of the plunger 45 and the member 47. The other projection 59 is arranged to engage a stop member, shown in the drawing as being constituted by the part 9 of the switch casing to which the fixed contact 5 is secured. At the end of the rod portion 53 of the member 47 remote from the plunger 45 there is a knob 67 which facilitates manual operation of the switch.

The operation of the switch will now be described.

The switch is operated by energising one or other of the windings of the solenoid coil 33 by applying a voltage to one or other of the leads 1 and C, the lead B being connected to ground.

In a first condition of the switch, the actuator armature 45, 47 is in the position shown in Figures 1 and 3 with the projection 59 resting against the stop member 9 under the action of spring 51 and with the contacts 5 and 19 in engagement under the action of, and with a contact pressure determined by, the spring 23. Operation of the switch into a second condition wherein the contacts 5 and 19 are disengaged and contacts 7 and 21 are engaged, as shown in Figure 2, is effected by energising that one of the windings of solenoid coil 33 which magnetises the solenoid pole piece 37 in the same sense as do the permanent magnets 39. As a result, the armature 45, 47, more particularly the plunger 45, is pulled axially into the solenoid coil 33 into contact with the pole piece 37. At an intermediate point along its path of travel, after the armature 45, 47 has built up appreciable momentum, the lobe 61 on the projection 57 of the member 47 strikes the contact arm 15 with sufficient force to ensure that the contacts 5 and 19 are disengaged despite any welding together of the contacts 5 and 19 which may have occurred, the rigid fixing of the contact 5 assisting in this. Thereafter the plunger 45 travels fully home into the solenoid coil 33 causing contacts 7 and 21 to engage with a contact pressure determined by the spring 13.

It will be appreciated that as the plunger 45 approaches the solenoid pole piece 37 the magnetic attractive force exerted on the plunger 45 increases so as to overcome succesively first the force exerted by spring 51, then the forces exerted by springs 23 and 51 and finally the forces exerted by springs 13, 23 and 51.

Once the plunger 45 is fully home in the solenoid coil 33, the energisation of the solenoid coil 33 is removed, the attractive force exerted by permanent magnets 39 alone then being sufficient to latch the plunger 45 in position against the forces exerted by springs 13, 23 and 51 due to the plunger 45 contacting the pole piece 37 and the magnetic circuit comprising the plunger 45, magnets 39, frame 41 and pole piece 37 being complete.

To return the switch to its first condition, the other winding of the solenoid coil 33 is energised so creating a magnetic field in the solenoid magnetic circuit which opposes the field of the magnets 39. As a result, the plunger magnetic holding force becomes less than the combined force exerted by springs 13, 23 and 51 and the armature 45, 47 more particularly the plunger 45 moves axially away from the pole piece 37. The contact arm 15 moves with the armature 45, 47, more particularly the member 47, firstly under the action of springs 13 and 23 together and after contacts 7 and 21

disengage under the action of spring 23 alone, until contacts 5 and 19 engage. Thereafter, armature 45, 47 continues to move axially under the action of spring 51 alone until the projection 59 on member 47 engages stop member 9, thereby establishing a gap between lobe 61 and contact arm 15. The energisation of the solenoid 31 may be removed as soon as a gap appears between plunger 45 and pole piece 37 and the force exerted by the magnets 39 on the plunger 45 is insufficient to overcome the force exerted by springs 13, 23 and 51.

It will be appreciated that by arranging for the armature 45, 47 to engage the arm 15 at a location further from the pivot pin 17 than the contact 19, the force available to break any welds between contacts 5 and 19 for a given momentum of the armature 45, 47 is optimised. Furthermore, the gap between lobe 61 and contact arm 15 when the switch is in its first condition can be made relatively large allowing greatly build up of momentum before the lobe 61 contacts arm 15. It is further pointed out in this connection that whilst in the switch described by way of example the moveable contact arm 15 is a rigid member pivoted to the casing, in other switches according to the invention the moveable contact arm may be an at least partly resilient member secured at one end to the casing, thus doing away with the requirement for the spring 23. However it will be understood in this connection that it is desirable for the part of the moveable contact arm between the moveable contact 19 and the point contacted by the lobe 61 to be substantially rigid to facilitate disengagement of contacts 5 and 19 despite welding.

It will be understood that whilst the switch described by way of example has two contact pairs, other switches in accordance with the invention may have a single contact pair only or more than two contact pairs. Furthermore, although in general it is desirable that contacts subject to possible welding are disengaged when the armature of the actuator is attracted by, rather than released by, the actuator electromagnet, this is not necessarily the case in a switch according to the invention.

Thus, for example, in a switch as described by way of example, some assistance in overcoming possible welding of contacts 7 and 21 may be obtained by arranging for member 47 to strike arm 15 on its top side shortly after the armature 45, 47 is released by the solenoid 31.

Claims

1. An electric switch comprising: a frame structure (9, 11); a fixed contact (5) rigidly located with respect to the frame structure (9, 11); a moveable contact arm (15) mounted for movement about one end (17) and carrying at a first location along its length a contact (19) arranged to engage and disengage said fixed contact (5) on movement of said contact arm (15); and electromagnetic actuator means (1) including an armature (45, 47) which moves along a path between first and second positions in operation of the actuator means(1); the armature (45, 47) having a surface (61) which is spaced from said contact arm (15) when the armature (45, 47) is in its first position, thereby allowing the contact arm (15) to take up a position in which said fixed and moveable contacts (5 and 19) are engaged, which surface (61) engages said contact arm (15) at a second location on said arm (15) only after said armature (45, 47) has passed an intermediate point along its path of travel from said first position to said second position, thereby to cause said contact arm (15) to take up a position in which said fixed and moveable contacts (5 and 19) are disengaged; said second location being further from said one end (17) of said contact arm (15) than said first location.

2. An electric switch according to Claim 1 wherein said actuator means (1) incorporates permanent magnet means (39) which serves to latch said armature (45, 47) in one of its positions.

3. An electric switch according to Claim 2 wherein said one position is said second position of the armature (45, 47).

4. An electric switch according to Claim 2 wherein said actuator means (1) further includes an electromagnet (31) arranged for energisation selectively either to assist or oppose the attractive force exerted by said permanent magnet means (39) on said armature (45, 47).

5. An electric switch according to Claim 4 wherein said electromagnet (31) comprises a solenoid (31) comprising a coil (33) carried on a pole piece (37); said permanent magnet means (39) comprises a magnet arrangement (39) surrounding a space aligned with the solenoid pole piece (37), there being a magnetic circuit path (41) between said magnet arrangement (39) and the end of the solenoid pole piece (37) remote from said space; and said armature (45, 47) includes a plunger member (45) of magnetic material arranged to slide within said space.

6. An electric switch according to Claim 5 wherein said surface (61) of said armature (45, 47) lies on a member of insulating material (47) secured to said plunger member (45).

7. An electric switch according to Claim 6 wherein said member of insulating material (47) includes a portion (53) disposed in line with said plunger member and said surface (61) lies on a projection (57) from said portion (53).

8. An electric switch according to any one of the preceding claims wherein said actuator means (1) includes armature resilient means (51) which urges the armature (45, 47) towards one of its positions.

9. An electric switch according to Claim 8 when dependent on Claim 2 wherein said resilient means urges said armature towards its position in which it is not latched.

10. An electric switch according to any one of the preceding claims including contact resilient means (23) which serves to provide a positive contact pressure between said contacts (5, 19) when engaged.

11. An electric switch according to Claim 10 when dependent on Claim 2 wherein said contact resilient means (23) acts on said contact arm (15) in such a direction as to tend to cause movement of said arm (15) in the opposite direction to the movement of said arm (15) caused by movement of the armature (45, 47) to said one position from its other position.

12. An electric switch according to any one of the preceding claims wherein said moveable contact arm (15) comprises a substantially rigid member (15) pivotally mounted at said one end (17) to said frame structure (9, 11).

Fig.1.

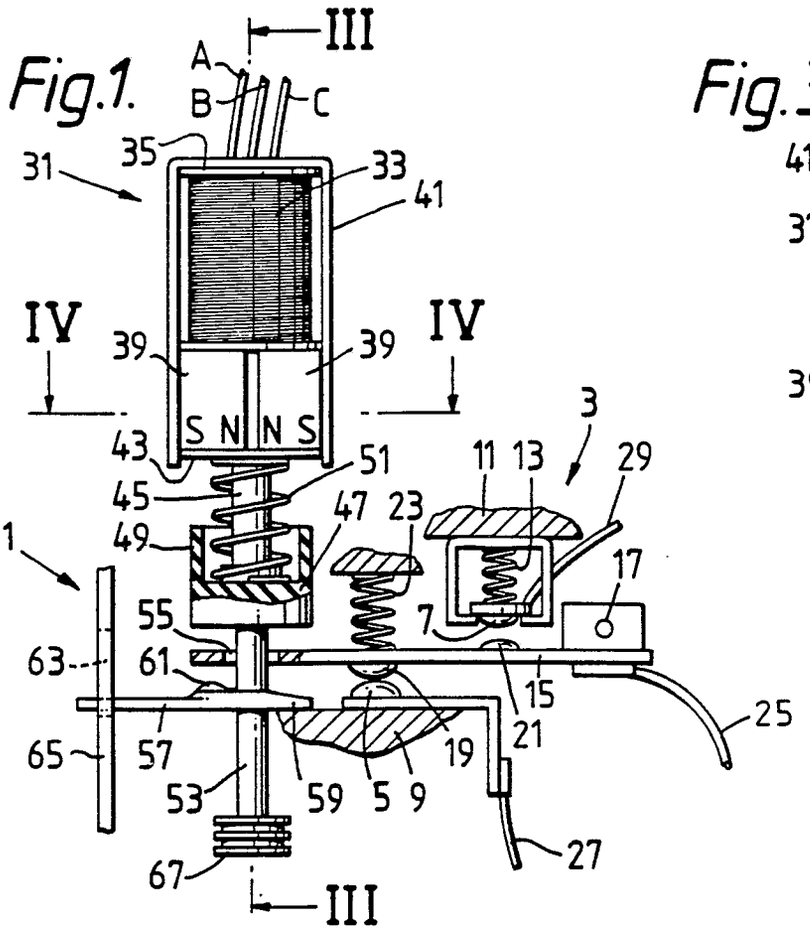

Fig.3.

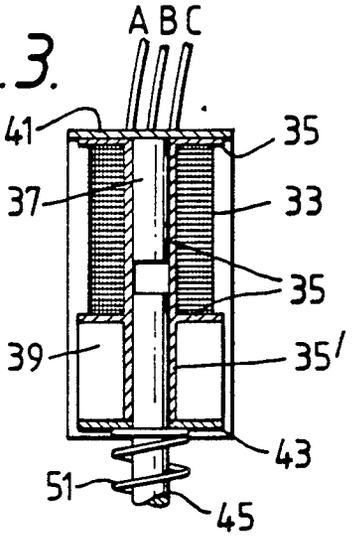

Fig.2.

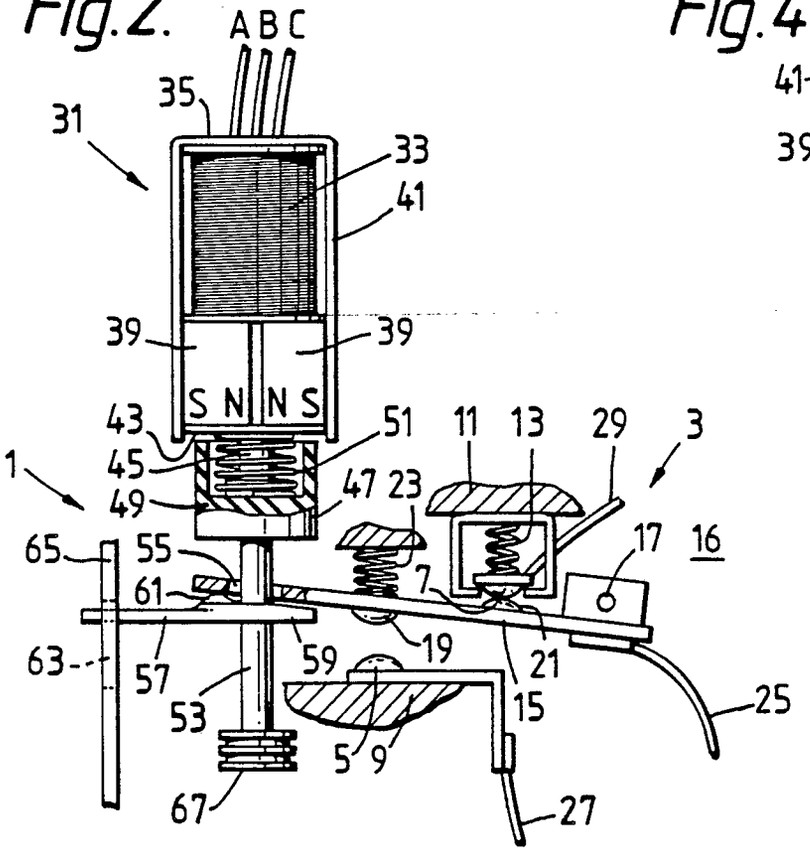

Fig.4.