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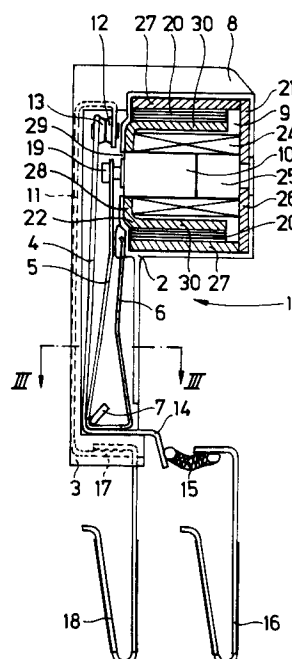
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(54) **Bistable electrical relay.**

(57) Bistable electrical relay (1) comprising a first contact (13), a movably mounted, essentially rigid arm (4) coupled thereto and provided with a first connecting point (14, 15, 16), and a second contact (12) coupled to an immovably mounted further arm (11) which is provided with a second connecting point (17, 18). To operate the contacts, electromagnetic drive means (9) are provided which act on the movable arm via spring means (5) for producing contact force. To keep the contacts closed, the drive means are provided with permanent magnets (20), while further spring means (6) act on the movable arm to keep the contacts open. Preferably, leaf springs are used, the two arms being mounted in close proximity in order to make use of the Lorentz force to produce additional contact force in the case of short-circuit currents. A switching module comprising bistable relays is also provided for switching group connecting points in an electrical power installation.

fig - 1



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The invention relates to a bistable electrical relay, in particular a bistable relay suitable for switching a connecting point or a group of connecting points in electrical power installations in buildings and the like, and also to a switching module provided with one or more bistable relays.

Bistable electrical relays are switching units having at least one pair of electrical contacts for switching an electrical circuit, comprising a movably mounted first contact and an essentially immovably mounted second contact, which contacts mutually touch in a first position (closed) and are mutually separated in a second position (open), having means for keeping the contacts in the first and in the second position, and having electromagnetically activatable drive means operatively coupled to the movable contact for altering the contact position.

This in contrast to monostable electrical relays, which have only one stable contact position and which can only be kept in the other position by continuously energising the electromagnetic drive means.

See, for example, British Patent Application GB-A-2,142,188.

In the closed position of the contacts, they have to mutually touch under the influence of a certain force, called the contact force. The magnitude of said contact force is dependent, inter alia, on the magnitude of the current to be switched by the contacts. To obtain a desired contact force, the movable contact is mounted, in the case of relays or electromagnetic switches known in practice, on or at the end of an electrically conducting leaf spring or flexible tongue, which leaf spring or tongue is then tensioned by bending it with the aid of the electromagnetically activatable drive means. Optionally, the fixed contact may also be mounted on a leaf spring or tongue, which is then bent or tensioned via the movable contact. See also, for example, Swiss Patent CH-A-234,220 and US Patent US-A-3,014,103.

Because the leaf springs or tongues are at the same time part of the circuit to be switched, switches or relays of this type are generally only suitable for switching relatively low currents. The higher the current intensities to be switched have to be, the larger the leaf springs or tongues have to be in size. To switch, for example, currents in the order of magnitude of 10A or higher, the contacts can generally no longer be mounted on leaf springs or tongues situated in the circuit because, as a consequence of the required, relatively large dimensions of said leaf springs or tongues, there occur in the latter unduly high flexural stresses which affect the service life of the switch or the relay adversely.

Accordingly, the object of the invention is in the first instance to provide a bistable relay without spring means, such as for example the leaf springs or tongues mentioned, in the circuit to be switched, so that the relay is also suitable for switching relatively high currents such as those which may occur in electrical power installations in buildings and the like.

According to the invention, this object is achieved by means of a movably mounted, essentially rigid arm coupled to the first contact, the drive means acting on said arm via spring means, which spring means are designed to provide a force for keeping the contacts in the first (closed) position and are not part of the circuit to be switched.

In the bistable relay according to the invention, the desired contact force is produced via separate spring means coupled to the drive means, via which spring means the drive means act on the movable arm coupled to the movable contact. The spring means are not part of the circuit to be switched. Both the spring means and the movable arm can now be optimally designed as regards the desired spring action or the required electrical characteristics for a particular application, the mutual arrangement of the contacts and the position of the drive means also being capable of being freely chosen.

It is pointed out that US Patent 4,099,151 discloses an electromagnetically operated switch in which the movable contact is mounted on a movable contact arm. Electromagnetically activatable drive means act on the movable contact arm via a compression spring. Because of the absence of means for keeping the contacts in the closed position, said switch cannot function as a bistable relay in accordance with the invention. This application is not in fact suggested. The emphasis is on the mechanical construction of the electrical connection between the movable contact arm and the associated fixed terminal.

In particular, if the bistable relay is used to switch connecting points or groups of connecting points in electrical power installations, it is necessary to prevent the contacts of the relay from being capable of being separated in the case of short-circuit currents and relatively high overload currents. Opening of the contacts under the influence of a short-circuit current would, after all, result in flashover, spark formation and, ultimately, in the so-called welding-together of the contacts of the relay. For this reason, bistable relays have not been separately used in circuits where such currents may occur.

Accordingly, the invention provides a further embodiment in which the movable arm is mounted so as to be pivotably supported at one end and the

movable contact is coupled to the other end of the arm such that the supported end forms a first contact connecting point, the fixed contact being coupled to one end of an immovably mounted further arm, the other end of which forms a second contact connecting point, which arms are mounted so as to be closely adjacent over at least a portion of their length and mutually insulated electrically such that, under the influence of an electrical current flowing through the two arms, mutually exerted magnetic forces are operative for keeping the contacts in their first (closed) position.

As a result of also coupling the fixed contact to a further arm in such a manner that said further arm and the movable arm in the closed position of the contacts of the relay are closely adjacent, use can advantageously be made of the known electromagnetic force action between adjacent, current-carrying electrical conductors (Lorentz forces), and in particular in such a manner that the contact force is thereby increased.

It will be clear that the use of the Lorentz effect in a movable arm of bistable relays constructed as a leaf spring or flexible tongue, as described above, is constructionally more difficult to implement as a result of the bending of the leaf spring or tongue necessary in the closed position of the contacts to achieve the desired contact force than in the embodiment of the invention in which the contacts are connected via rigid arms. This is the case, in particular, in comparison with a further embodiment of the invention in which the two arms have an elongated flat shape, at least as regards the adjacently situated parts, and can accordingly be mounted closely adjacent in order to produce an as high as possible mutual magnetic force action between the arms.

A constructionally relatively simple and advantageous embodiment of the bistable relay according to the invention is one in which the respective contacts are fitted in a fixed manner on the associated arm. Note, in particular, that to obtain the abovementioned advantages of the invention, a construction can also be provided in which, for example, the movable contact is mounted in a separately movable manner and is activated via the movable arm.

To make electrical contact to the contact connecting point of the movable arm, use can be made, for example, of litzwire or, according to yet a further embodiment of the invention, a sliding contact transmission can be provided as a result of which the necessary welding and/or soldering operations for joining the litzwire are avoided.

As has already been described above, the invention is not restricted to specific spring means, such as for example helical springs (tension and compression springs), spiral springs and the like

for providing a desired contact force.

Because bistable relays are capable, in particular, of being remotely controlled and can be used to make (existing) electrical installations remotely controllable, the invention is also aimed at providing a bistable relay of as small dimensions as possible. The incorporation or integration of bistable relays in existing components (switching units, cut-out units, etc.) will then be simpler.

An embodiment of the invention which is suitable, inter alia, for this purpose is one in which the spring means consist of a first leaf spring which extends in the longitudinal direction of the movable arm and of which one end is coupled in a fixed manner to the movable arm and of which the other end is coupled to the drive means, the end coupled to the drive means being held at a predetermined greater spacing from the movable arm than the end coupled to the movable arm, and the contacts being arranged such that they can be set to the first (closed position) by moving the end, coupled to the drive means, of the first leaf spring away from the movable arm.

In addition to the characteristics of the spring material used and the bending of said leaf spring caused by the drive means in the closed position of the contacts, the contact force thereby produced is further influenced by said spacing between the ends of the leaf spring measured in the direction perpendicular to the plane thereof. The desired contact force can be influenced by varying said spacing. This is important for providing a desired minimum contact force for a predetermined contact spacing, that is the spacing between the contacts in their second (open) position. Because the drive means can bend or tension the leaf spring only over a fixed distance, the contact force provided by the leaf spring will become lower for a greater contact spacing resulting from wear of the contacts. This loss of contact force can be absorbed by presetting the leaf spring by means of a spacer.

In yet a further embodiment of the invention, likewise with a view to achieving as small dimensions as possible, the means for keeping the contacts in a certain position consist of further spring means in the form of a second leaf spring which extends in the longitudinal direction of the movable arm and of which one end is supported and of which the other end is operatively coupled to the movable arm, which second leaf spring is pretensioned so as to keep the movable arm in the desired position.

In an embodiment of the invention, the first leaf spring and second leaf spring can be integrally formed, the first leaf spring being mounted adjacent to the movable arm and the two leaf springs being fixedly connected by their one end to the movable arm in the vicinity of the pivot point there-

of. In this manner, a contact and spring assembly is obtained which forms a single unit and which can readily be assembled without the need for fixing screws, adjustment screws or the like. It will be clear that, seen from the point of view of assembly, such a unit is very advantageous, in particular, as the dimensions of the relay become smaller because, in the case of several constituent components, the dimensional requirements (tolerances) to be imposed thereon become stricter and can be achieved less easily sometimes only with higher costs.

If, for example, the second leaf spring is used for keeping the contacts in the second (open) position, the spring action thereof will generally have to be less than the spring action of the first leaf spring designed to obtain a desired contact force. After all, the second leaf spring then acts in opposition to the first leaf spring. If the leaf springs are constructed as a single entity, that is to say are formed from the same spring material, the spring action of the second leaf spring can, according to an embodiment of the invention, readily be set to a desired value by selectively removing leaf material.

In a further embodiment of the relay according to the invention, operating means coupled to the spring means acting on the movable arm are provided for mechanically altering the position of the contacts. It is consequently possible to alter the position of the contacts not only electromagnetically but also mechanically, for example by hand. By making the operating means suitable for mutual coupling thereof, it is possible to ensure that, if, for example, the phase and neutral connections of a circuit are switched by different relays or, if the phases in a three-phase circuit are switched by separate relays, all the phases or the neutral of an electrical installation are switched on and/or off simultaneously.

The operating means act preferably on the end of the first leaf spring coupled to the drive means. To operate the contacts by hand, an L-shaped operating arm of electrically insulating material coupled to the first leaf spring is provided in yet a further embodiment of the invention with a limb extending perpendicularly to the leaf spring as operating handle.

As has already been pointed out above, the bistable relay according to the invention is suitable, in particular, for the remote switching of the energy supply for connecting points or groups of connecting points in an electrical power installation. With a view to the well-defined control of electrical installations without complex circuits or measures, and also in view of the present trend towards automation in the control of electrical power installations for buildings and the like, the preferred embodiment of the bistable relay according to the inven-

tion comprises drive means for the activation thereof with electrical pulses of either polarity to alter the position of the contacts.

Such a bistable relay has the advantage that the position of the contacts can be determined or is known from the activating pulse applied last. If the drive means are designed, for example, in such a way that, on being energised by a positive voltage pulse, they are operative for setting the contacts to the first (closed) position and for setting the contacts to the second (open) position by means of a negative voltage pulse, it can be concluded from the fact that, for example, a positive pulse has been applied, that the contacts are in their first position in which they are retained and that, after applying a negative pulse, the contacts are in their second position, in which they are also retained. Such a bistable relay is suitable, in particular, for application in combination with digital control means, such as a microprocessor or the like, with memory means for recording the polarity of the pulse applied last. An undefined state of the contacts as a consequence of the contact chatter which always occurs in the case of mechanical switches and as a result of which it is not a single pulse which is generated but a train of short pulses of the same polarity, is eliminated under these circumstances. After all, pulses of the same polarity will not bring about any alteration in the position of the contacts.

To drive the bistable relay according to the invention, suitable compact drive means which can be activated in a well-defined manner by pulses of different polarity comprise, according to an embodiment of the invention, a first yoke of magnetic material having an essentially U-shaped section and a cylindrical electrical coil extending from the closed end to the open end in said first yoke, provided with a core of magnetic material extending partly in the space bounded by the coil and magnetically coupled to the first yoke and a movable armature of magnetic material, and having a second yoke of magnetic material having a likewise essentially U-shaped section, which second yoke is fitted in an inverted manner with respect to the first yoke over the coil in the first yoke, one or more permanent magnets being fitted in the space between the adjacently situated parts of the two yokes for keeping the contacts in the first (closed) position and the second yoke being provided with an opening through which the armature can be moved outwards so as to act on the spring means coupled to the movable arm.

The permanent magnets which are used in the drive means and which are able to hold the armature against the core in the coil provide the desired force for keeping the contacts in the first (closed) position. As a supplement to the spring

means coupled to the drive means, said permanent magnets also provide a contribution to the contact force. The drive means are very compact in construction and easy to assemble, it being readily possible to fit a greater or lesser number of permanent magnets to set a desired holding force as a result of the relatively large area between the limbs of the two yokes.

To absorb tolerances in the yokes, the coil and the core as much as possible, at least the first yoke is preferably assembled from separate parts made of magnetic material.

A spacer suitable for use in the drive means according to the invention for setting the contact force in combination with said first leaf spring is, in an embodiment of the invention, constructed as a body having a locally constricted section, the first leaf spring being provided with a slot with which it acts on said body at the point of the constriction in the section. The spacer is attached to the outwardly movable portion of the armature.

To assemble the contact arms, spring means and drive means, an approximately L-shaped housing of electrically insulating material is provided in the preferred embodiment of the invention, the drive means being situated in the space bounded by the short limb of the housing and the long limb having an approximately S-shaped section, in one half of which the fixed arm and the other half of which the movable arm are arranged.

The S-shaped section of the housing for receiving the contact arms produces a specified adequate creepage path between said contact arms in order to effectively prevent creepage currents resulting from contamination of the housing or atmospheric conditions, a spacing which is as small as possible also being obtained between the contact arms to achieve an as high as possible mutual magnetic force action for keeping the contacts in the first (closed) position during the occurrence of short-circuit currents or relatively high overload current in the circuit switched by the relay.

To mutually couple the operating means for mechanically altering the position of the contacts of different relays, the housing is provided, in a further embodiment, with a pivotable pawl which is fitted near the short limb thereof and acts on the operating arm.

It is pointed out that the housing, in particular for use in the embodiment of the relay according to the invention in which the movable arm and the spring means are combined as a single entity, does not need to be provided with projections or recesses for receiving screws and the like. The housing can advantageously be used as an assembly table for assembling the various components of the relay. The relay can then be constructed as a separate module and be used, for example, in

combination with safety switches such as automatic overload devices and automatic earth fault devices which protect an electrical installation against overload currents and earth fault currents.

Accordingly, the invention also relates to a switching module provided with a bistable relay according to one or more of the preceding claims, comprising a housing provided with electrical terminals and a switching element having a pair of contacts for making or breaking an electrical connection between predetermined terminals, the contacts of the bistable relay being connected electrically in series with the contacts of the switching element and the housing being provided with control signal terminals for energising the electromagnetically activatable drive means of the bistable relay.

A switching module provided with a switching element and electrical terminals devices for use in an electrical installation for, for example, interrupting the electrical power supply if overload currents or earth fault currents occur is disclosed, inter alia, in European Patent Application 0,322,986, European Patent Application 0,345,851 and European Patent Application 0,405,688, all in the name of the Applicant, which applications should be regarded as incorporated herein.

In a further embodiment of the switching module according to the invention, both the contacts of the bistable relay and the contacts of the switching element are connected to terminals of the housing. This has the advantage that it is possible to connect to the switching module a plurality of circuits which can be switched, on the one hand, solely by means of the switching element and, on the other hand, are switchable by means of both the switching element and the bistable relay. In this manner, separate connecting points or groups of connecting points can be switched on or off, for example remotely, from the power distribution point by means of a bistable relay. In this connection consideration can be given to the switching of lighting for safety purposes or air-treatment equipment, or the common switching of all the connecting points in the building from a centre point.

For switching either in the phase connection or neutral connection of an electrical installation or for switching all the phases of a three-phase electrical installation, the switching module according to the invention can be provided with one or more separate bistable relays. To energise said relays, the drive means may be connected, for example, in parallel to the signal terminals, or be constructed separately, and the operating means of the separate relays can be mutually coupled mechanically in order to switch off the phase or neutral connections simultaneously or virtually simultaneously.

In yet a further embodiment of the switching module according to the invention, the signal terminals are fitted on a resilient support body borne in the housing of the switching module. As a result of resilient bearing of the signal terminals, damage to the signal terminals themselves and the terminals to which they are coupled is prevented as far as possible. This is necessary, in particular, if the bistable relays are used in relatively large switching modules provided with robust pluggable terminals and the signal terminals being constructed, for example, in the form of an edge connector for making contact to contact pads provided at the edge of a substrate, for example a printed circuit board.

A support body suitable for resiliently bearing the signal terminals has, according to a further embodiment, an essentially block-shaped periphery, with resilient members situated on two oppositely situated sides in the direction perpendicular thereto, a further side connecting to said sides and rounded off in the direction thereof and a side, situated opposite said further side, for mounting the signal terminals thereon.

In the preferred embodiment, the support body is made of plastic and has an essentially M-shaped section provided with a widened central section or base part for mounting the signal terminals thereon, the base part being provided, in the plane of the M-shaped section, with at least one upright wall extending outside the periphery of the support body, which wall is rounded off laterally in the direction of the base part at the end remote from the base part, the housing of the switching module being provided with an essentially rectangular compartment having a length, width and depth for the reception of the support body, the length being chosen such that the support body can be slid in the direction perpendicular to the plane of the M-shaped section, the width being less than the dimensions of the support body in the plane of the M-shaped section parallel to the base part, with a depth essentially equal to the dimensions of the support body in the plane of the M-shaped section perpendicular to the base part, and with an opening through which the signal terminals can extend outside the housing. Preferably, the support body is made of a thermoplastic, such as for example polyamide.

The invention is described in greater detail below by reference to a preferred embodiment of a bistable relay, a switching module equipped therewith and a support body for the resilient bearing of the signal terminals of a bistable relay.

Figure 1 shows diagrammatically, partially in section, the front view of a preferred embodiment of the bistable relay according to the invention.

Figure 2 shows diagrammatically the rear view of the bistable relay in Figure 1.

Figure 3 shows diagrammatically the section along the line III-III in Figure 1.

Figure 4 shows diagrammatically a side view of the bistable relay in Figure 1.

Figure 5 shows diagrammatically and in part a further embodiment of the bistable relay according to the invention.

Figure 6 shows diagrammatically, partly in section, a view of a switching module provided with a bistable relay according to Figure 1.

Figure 7 shows diagrammatically and in perspective the preferred embodiment of a support body used in the switching module in Figure 6 for the resilient bearing of the signal connecting devices of the bistable relay.

Figure 8 shows diagrammatically and in perspective a bistable relay according to the invention constructed as a separate module and mounted in the housing of a switching module, such as for example the switching module shown in Figure 6.

The bistable relay 1 shown in Figure 1 comprises an approximately L-shaped plastic housing 2, in whose long limb 3 an essentially rigid, movable arm 4 of electrically conducting material is accommodated, and also a first leaf spring 5 fulfilling the function of contact force spring and a second leaf spring 6 one end of which acts on the first leaf spring 5 and its other end rests against a wall of the housing 2. The movable arm 4 and the two leaf springs 5, 6 are movably supported by means of a projection 7 formed in the housing and upright walls of the housing 2.

Mounted in the short limb 8 of the housing 2 are electromagnetically activatable drive means 9 provided with an armature 10 which is able to move in the direction perpendicular to the arm 4.

Extending adjacently to the movable arm 4 in the housing is a further arm 11 of electrically conducting material, which is shown in Figure 1 by means of broken lines. Said further arm 11 is immovably mounted in the housing and terminates near the drive means 9 in an immovably mounted contact 12. Opposite said fixed electrical contact 12 is an electrical contact 13 mounted on the movable arm 4.

The supported end of the movable arm 4 forms a first contact connecting point 14 which is movably and electrically connected to a contact terminal 16 via a litzwire 15. The other end of the further arm 11 forms a second contact connecting point 17 which is either connected in a fixed manner, for example soldered, or forms a single entity with a contact terminal 18.

In the first position shown, in which the contacts 12 and 13 mutually touch, the two arms 4, 11 carry oppositely directed currents during operation. This produces, around the conductors, a magnetic field having a mechanical force action (Lorentz

forces) in the direction of mutual removal of the arms. From the figure it can be clearly seen that the contacts 12, 13 are thereby pressed more strongly against one another. This contact-force-increasing action is advantageous if short-circuit currents and relatively high overload currents occur in a circuit switched by the contacts 12, 13. This effectively eliminates the risk that the contacts 12, 13 can be opened by the activation of the drive means 9 in the event of a short-circuit current and may be damaged consequently by flashover, spark formation and the like. To produce as high a mutual magnetic force action as possible, the arms 4, 11 are constructed as far as possible as flat conductors, as a result of which they can be mounted in a closely adjacent manner over a relatively large portion of their surface.

As can be clearly seen from Figure 1, the two leaf springs 5, 6 are not part of the electrical circuit formed by the two arms 4, 11. This means that the arms 4, 11 can be optimally dimensioned with regard to the desired electrical characteristics and the two leaf springs 5, 6 with regard to the desired spring action.

Near the supported end of the movable arm 4, the first leaf spring 5 is firmly joined thereto, for example by means of soldering or a so-called compression joint. The other end of the first leaf spring 5 is coupled to the armature 10 of the drive means 9. By means of a spacer 19, this end of the first leaf spring 5 is kept at a greater distance from the movable arm 4 than the end of the first leaf spring 5 attached to the arm 4. This produces a static pretensioning of the first leaf spring 5. To separate the contacts 12, 13, that is to say to take them from the first (closed) position to the second (open) position thereof, this pretension, or contact force, has to be overcome.

The contacts 12, 13 can be set to their first, closed position by moving the movable arm 4 by means of the first leaf spring 5 or the armature 9 coupled thereto in the direction of the fixed contact 12. During this operation, the first leaf spring 5 is also additionally tensioned, as a result of which the contacts 12, 13 are held against one another with a certain force which is added to the contact force already reached by pretensioning the leaf spring 5.

If the spacing between the contacts 12, 13 in their second (open) position becomes larger during use as a result of wear, said added force decreases because the armature 10 of the drive means 9 can only be moved over a certain fixed distance. In practical applications, the first leaf spring 5 is therefore pretensioned in such a manner that a desired minimum contact force is guaranteed for a certain maximum contact spacing produced during operation, which contact spacing corresponds to a predetermined number of switching

operations of the contacts, that is to say the service life thereof.

The spacer 19 is preferably a head-shaped body of electrically insulating material coupled to the armature 10 and having a locally constricted section on which the first leaf spring 5 acts, as shown, by means of a slot provided therein.

To keep the contacts 12, 13 in the first, closed position, the drive means 9 are provided with one or more permanent magnets 20 which act magnetically on the armature 10 via a magnetic circuit consisting of a first yoke 21 and a second yoke 22 of magnetic material and a core 25 of magnetic material mounted in a fixed manner inside an elongated electrical coil 24.

The first yoke 21 has an approximately U-shaped section, with a closed base part 26 and with one or more walls 27 extending transversely to the base part 26. The second yoke 22 likewise has an approximately U-shaped section, with a base part 28 provided with an opening 29 through which the armature 10 can move and with upright walls 30. The dimensions of the second yoke 22 are smaller than those of the first yoke 21, and to be precise, such that the second yoke 22 can be positioned, as shown, inside the periphery of the first yoke 21. The permanent magnets 20 are positioned between the walls 27 and 30. From the base part 26 of the first yoke 21, the elongated electrical coil 24, containing the core 25, extends inside the space bounded by the second yoke 22.

In the first position, which is shown and in which the contacts 12, 13 are closed, the armature 10 rests against the core 25 and it is retained in this position under the influence of the magnetic field generated by the permanent magnets 20. As a result of applying, via connecting ends which are not shown, a voltage to the coil 24 of a certain polarity which results in an electrical current having a certain direction, an electromagnetic field can be generated in the core 25 and the armature 10 which is directed in opposition to the permanent magnetic field, as a result of which the retaining force of the permanent magnetic field on the armature 10 is nullified or its direction may even be reversed. If the force exerted by the second leaf spring 6 on the movable arm 4 in the direction of opening of the contacts 12, 13 is greater than the resultant magnetic force on the armature 10, the contacts 12, 13 will be moved to their second, open position under the influence of the mechanical spring action and will be kept in this position by means of the second leaf spring 6. The whole system is dimensioned in such a manner that the air gap which appears in this case between the armature 10 and the core 25 forms a magnetic resistance sufficient to prevent the armature 10 being pulled against the core 25 under the influ-

ence of the permanent magnetic field. As a result of supplying to the coil 24 an electrical voltage having a polarity such that an electromagnetic field cooperative with the permanent magnetic field is generated in the armature 10 and the core 25, the movable arm 4 will be moved in the direction of the fixed contact 12 by means of the first leaf spring 5 after overcoming the force exerted by the second leaf spring 6, with the result that the contacts 12, 13 are again set to their first, closed position, the first leaf spring 5 again being additionally over-tensioned.

With this embodiment of the drive means 9, it is therefore possible to set the contacts 12, 13 to a first, for example closed, position with an electrical current through the coil 24 in one direction and to cause them to occupy a second, open position with the aid of an electrical current in the other direction. As described in the introduction, this has the advantage that the position of the contacts 12, 13 is unambiguously known as a result of recording the polarity of the activating pulse applied last. This is advantageous, in particular, when combined with a digital control unit, such as for example a micro-processor. Furthermore, contact chatter if mechanical drive switches 9 are used to energise the drive means 9 has no influence on the desired position of the contacts 12, 13.

The embodiment of the drive means 9 which has been shown and described is compact in construction and, as a result of constructing the first yoke 21 from separate parts 26, 27, tolerances in the dimensions of the other components of the magnetic system can be effectively absorbed.

Instead of the embodiment of the drive means 9 discussed, other embodiments, such as for example an embodiment in which the core 25 is replaced by a permanent magnet, can of course also be used. The coil 24 may also consist of two or more windings for altering the position of the contacts 12, 13, for example, with voltage pulses or current pulses of the same polarity.

It can be clearly seen from the view of the bistable relay 1 shown in Figure 2 that the further arm 11, on which the fixed contact 12 is mounted, is fitted in said bistable relay at a side of the housing 2 other than that at which the movable arm 4 and the respective leaf springs 5, 6 are fitted.

Figure 3 shows a section along the line III-III of the long limb 3 of the housing 2. This essentially S-shaped section achieves a long path, which is sufficient in accordance with specification, for creepage currents between the two arms 4, 11 while maintaining a closely adjacent, electrically insulated mounting of the two arms in order to achieve an as large as possible mutual magnetic influence (Lorentz effect).

From the side view of the housing 2 shown in Figure 4 it can be clearly seen that the relay can be of relatively flat construction, with flat contact arms.

As can be seen from Figure 1, the leaf springs 5 and 6 are formed as a single entity from, for example, phosphorbronze. At the same time the second leaf spring 6 has a meander shape obtained by selectively removing leaf material in order to achieve the desired spring action. Although constructing the two leaf springs 5, 6 as a single entity is advantageous for assembly, this is not necessary per se to achieve the desired action of the bistable relay.

Figure 5 shows very diagrammatically that, instead of leaf springs, torsion springs, such as tension and compression springs, can be used. The tension spring 31 coupled to the movable arm 4 fulfils the function of contact force spring, comparable with the first leaf spring 5 in the embodiment according to Figure 1 in which the drive means act in that case on the other end 32 of said tension spring 31 (not shown). To set the contacts 12, 13 to the open position, use may be made, for example, of a compression spring 33 whose one end rests against the housing 2, diagrammatically indicated by the line 34 and whose other end acts on the movable arm 4. It will be clear that the use of helical springs, and also of spiral springs and the like, may result in an increase in the dimensions of the bistable relay compared with the embodiment employing leaf springs and that forces, for which it must be dimensioned, also act on the housing. The leaf springs 5, 6 in the embodiment according to Figure 1 essentially form a closed-loop force system, as a result of which it is possible to make do with a housing 2 of relatively light construction.

Figure 5 also shows, diagrammatically, a sliding contact transmission for making electrical contact with the movable arm 4. In its simplest embodiment, said sliding contact transmission comprises a roller 35 with spring means 36 for providing an adequate contact pressure between the roller 35 and the contact connecting point 14 of the movable arm 4.

Figure 6 shows a switching module provided with a bistable relay in the embodiment according to Figure 1.

The switching module 40 comprises a plastic housing provided with connecting devices 41 and a switching element consisting of a lever 42 and a leaf spring 43 coupled thereto. Said leaf spring 43 can be tensioned by means of a pawl 44, which acts on the connecting point of the lever 42 and the leaf spring 43, and on an operating key 45 coupled thereto. Mounted at the other end of the leaf spring 43 is a movable contact 46 which can be brought into contact with an immovably moun-

ted contact 47. As a result of the tensioning of the leaf spring 43, the contacts 46, 47 are pressed against one another and locked in this position by the pawl 44. The locking can be released with the aid of a pivotably mounted further lever 48 which acts on said pawl 44, after which the contacts 46, 47 will be opened under the influence of the spring force of the leaf spring 43. To activate the lever 48, a control device 49 is provided which has a movable armature 50 which can act on the end of the lever 48.

For more details regarding the action of the switching element, reference is made to said European Patent Application 0,322,986.

The contacts 12, 13 of the bistable relay 1 are connected, as shown, via their respective arms 11, 4 to the terminals of the switching module 40. The fixed contact 47 of the switching element is at the same time connected to a separate terminal 51, just like the fixed contact 11 of the bistable relay, which is electrically connected to a terminal 52. The movable contact 46 of the switching element and the movable contact 13 of the bistable relay 1 are both connected to a terminal 53.

An electrical circuit connected between the terminals 51 and 52 can now be switched off both via the bistable relay and the contacts 46, 47. An electrical circuit connected between the terminals 51 and 53 can only be interrupted via the contacts 46, 47 of the switching element. If such a switching module is used in an installation box such as that described in said European Patent Application 0,345,851, one or more group connecting points of an electrical installation can be remotely switched by means of the bistable relay 1 from the energy distribution point in an electrical installation. Separate control signal terminals 60 are provided for energising the drive means 9 of the bistable relay 1.

The switching module 40 may contain one or more separate switching units or a switching unit provided with a plurality of pairs of contacts 46, 47 in series with each of which a separate bistable relay 1 can be incorporated.

To carry out, for example, a two-pole (phase and neutral) or multiphase switching operation, the bistable relays are provided with operating means, for example in the form of an L-shaped operating arm 54 as shown in Figure 6, coupled to the movable arm 4. The relay can then be switched on and off by hand from outside the housing of the switching module 40 via a pivotable pawl 57 which acts on the short limb 55 of said operating arm 54 and which forms a single entity with a push button 54 and is rotatably mounted around a pivot point 59. The pivotable pawl 57, which can act on the operating arm 54, can be coupled mechanically via a connecting rod 58 to corresponding pawls 57 of

further bistable relays accommodated in the switching module. This then brings about an essentially simultaneous transition from one contact position to the other of the contacts of all the bistable relays accommodated in the switching module. The connecting leads 62, 63 for energising the drive means 9 of the separate bistable relays may at the same time be connected in parallel or separately to the signal terminals 60.

In Figure 6, the signal terminals 60 are constructed as a so-called edge connector for making contact with a printed circuit board 64 via which the control signals for the bistable relays are supplied.

In the preferred embodiment of the switching module according to the invention, the signal terminals 60 are preferably mounted on a support body 70 which is resiliently borne in the housing of the switching module 40. This is to prevent damage to the board 64 if the signal terminals 60 make contact at an angle with respect to the printed circuit board 64, as illustrated.

Figure 7 shows a preferred embodiment of the support body 70, which has an essentially M-shaped section having a widened central section or base part 71 for mounting the signal terminals. For the purpose of the description, an X,Y,Z axes system is shown. The V-shaped side walls 73 of the support body can be compressed in the Y direction, upright walls 74, which are rounded off towards the base part 71, furthermore extending from the base part 71 in the Z direction. As a result, the support body can be rotated in the Y,Z plane. The base part 71 is preferably also rounded off laterally at its support edges 72, as shown, in order to facilitate rotation in the Y,Z plane. The support body is preferably made of thermoplastic having resilient characteristics, such as for example a polyamide.

The housing 40 of the switching module is provided with a compartment 75 having dimensions such that the resilient walls 73 are constrained therein in a slightly compressed manner and the rounded-off sides of the walls 74 rest against the rear wall 79 of the compartment when making contact to the connecting devices 60. In the direction perpendicular to the plane of the drawing, the X direction in Figure 7, the dimensions of the compartment 75 are such that the support body 70 can be slid in said direction. The connecting devices 60 are flexibly positionable in the three axial directions X, Y, Z (Fig. 7) by means of the support body 70.

Figure 8 shows a bistable relay constructed as a separate module 80 for use in a housing of a switching module, for example the switching module shown in Figure 6.

To a person skilled in the art it will be clear that many modifications and additions can be

made to the preferred embodiments, described above, of the bistable relay according to the invention, a switching module equipped therewith and a support body for the signal terminals without, however, departing from the inventive idea described in the application.

Claims

1. Bistable electrical relay, comprising at least one pair of electrical contacts for switching an electrical circuit, consisting of a movably mounted first contact and an immovably mounted second contact, which contacts mutually touch in a first position (closed) and are mutually separated in a second position (open), having means for keeping the contacts in the first and second positions and having electromagnetically activable drive means operatively coupled to the movable contact for altering the position of the contacts, characterised by a movably mounted, essentially rigid arm coupled to the first contact, the drive means acting on said arm via spring means, which spring means are designed to provide a force for keeping the contacts in the first (closed) position and are not part of the circuit to be switched.
2. Bistable relay according to Claim 1, wherein the movable arm is mounted so as to be pivotably supported at one end and the movable contact is coupled to the other end of the arm such that the supported end forms a first contact connecting point, the fixed contact being coupled to one end of an immovably mounted further arm, the other end of which forms a second contact connecting point, which arms are mounted so as to be closely adjacent over at least a portion of their length and mutually insulated electrically such that, under the influence of an electrical current flowing through the two arms, mutually exerted magnetic forces are operative for keeping the contacts in their first (closed) position.
3. Bistable relay according to Claim 2, wherein the two arms have an elongated flat shape at least as regards the adjacently situated parts.
4. Bistable relay according to one or more of the preceding claims, wherein the spring means consist of a first leaf spring which extends in the longitudinal direction of the movable arm and of which one end is coupled in a fixed manner to the movable arm of which the other end is coupled to the drive means, the end coupled to the drive means being held at a

predetermined greater spacing from the movable arm than the end coupled to the movable arm, and the contacts being arranged such that they can be set to the first (closed) position by moving the end, coupled to the drive means, of the first leaf spring away from the movable arm.

5. Bistable relay according to Claim 2, 3 or 4, wherein the means for keeping the contacts in a certain position comprise further spring means in the form of a second leaf spring which extends in the longitudinal direction of the movable arm and of which one end is supported and of which the other end is operatively coupled to the movable arm, which second leaf spring is pretensioned so as to keep the movable arm in the desired position.
6. Bistable relay according to Claim 5, wherein the first and second leaf spring form a single entity, the first leaf spring being mounted adjacent to the movable arm and the two leaf springs being fixedly connected by their one end to the movable arm in the vicinity of the pivot point thereof, the other end of the second leaf spring acting on the first leaf spring.
7. Bistable relay according to one or more of the preceding claims, provided with operating means which are coupled to the spring means acting on the movable arm for mechanically altering the position of the contacts, which operating means act, in particular, on the end of the first leaf spring coupled to the drive means.
8. Bistable relay according to one or more of the preceding claims, provided with drive means for the activation thereof with electrical pulses of either polarity to alter the position of the contacts.
9. Bistable relay according to one or more of the preceding claims, in which the drive means comprise a first yoke of magnetic material having an essentially U-shaped section, a cylindrical electrical coil extending from the closed end to the open end in said first yoke, provided with a core of magnetic material extending partly in the space bounded by the coil and magnetically coupled to the first yoke and a movable armature of magnetic material, and having a second yoke of magnetic material having a likewise essentially U-shaped section, which second yoke is fitted in an inverted manner with respect to the first yoke over the coil in the first yoke, one or more permanent magnets being fitted in the space between the

adjacently situated parts of the two yokes for keeping the contacts in the first (closed) position and the second yoke being provided with an opening through which the armature can be moved outwards so as to act on the spring means coupled to the movable arm.

10. Bistable relay according to Claim 9, dependent on Claim 4, provided with a body which is attached to the portion of the armature which can be moved outwards and which has a locally constricted section, the first leaf spring being provided with a slot with which it acts on said body at the point of the constriction in the section. 10
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11. Bistable relay according to one or more of the preceding claims, dependent on Claim 3, provided with an approximately L-shaped housing of electrically insulating material, the drive means being situated in the space bounded by the short limb of the housing and the long limb having an approximately S-shaped section, in one half of which the fixed arm and in the other half of which the movable arm are arranged. 20
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12. Switching module, provided with a bistable relay according to one or more of the preceding claims, comprising a housing provided with electrical terminals and a switching element having a pair of contacts for making or breaking an electrical connection between predetermined terminals, the contacts of the bistable relay being connected electrically in series with the contacts of the switching element and the housing being provided with control signal terminals for energising the electromagnetically activatable drive means of the bistable relay. 30
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13. Switching module according to Claim 12, wherein both the contacts of the bistable relay and the contacts of the switching element are connected to terminals of the housing. 45
14. Switching module according to Claim 12 or 13, comprising a switching element provided with a plurality of pairs of contacts and a plurality of bistable relays, the contacts of one or more separate bistable relays being electrically connected in series with a pair of contacts of the switching element. 50
15. Switching module according to Claim 12, 13 or 14, wherein the signal terminals are fitted on a support body resiliently borne in the housing of the switching module, the support body having an essentially block-shaped periphery, with re- 55

silient members situated on two oppositely situated sides in the direction perpendicular thereto, a further side connecting to said sides and rounded off in the direction thereof and a side, situated opposite said further side, for mounting the signal terminals thereon.

16. Switching module according to Claim 15, in which the support body is made of plastic and has an essentially M-shaped section with a widened central section or base part for mounting the signal terminals thereon, the base part being provided, in the plane of the M-shaped section, with at least one upright wall extending outside the periphery of the support body, which wall is rounded off laterally in the direction of the base part at the end remote from the base part, the housing of the switching module being provided with an essentially rectangular compartment having a length, width and depth for the reception of the support body, the length being chosen such that the support body can be slid in the direction perpendicular to the plane of the M-shaped section, the width being less than the dimensions of the support body measured in the plane of the M-shaped section parallel to the base part, with a depth essentially equal to the dimension of the support body measured in the plane of the M-shaped section perpendicular to the base part, and with an opening through which the signal terminals can extend outside the housing.
17. Switching module according to Claim 12, 13, 14, 15 or 16, wherein the signal terminals have the form of an edge connector in order to make contact to contact pads provided at the edge of a substrate.
18. Support body as described in Claim 15 or 16.

fig - 1

fig - 4

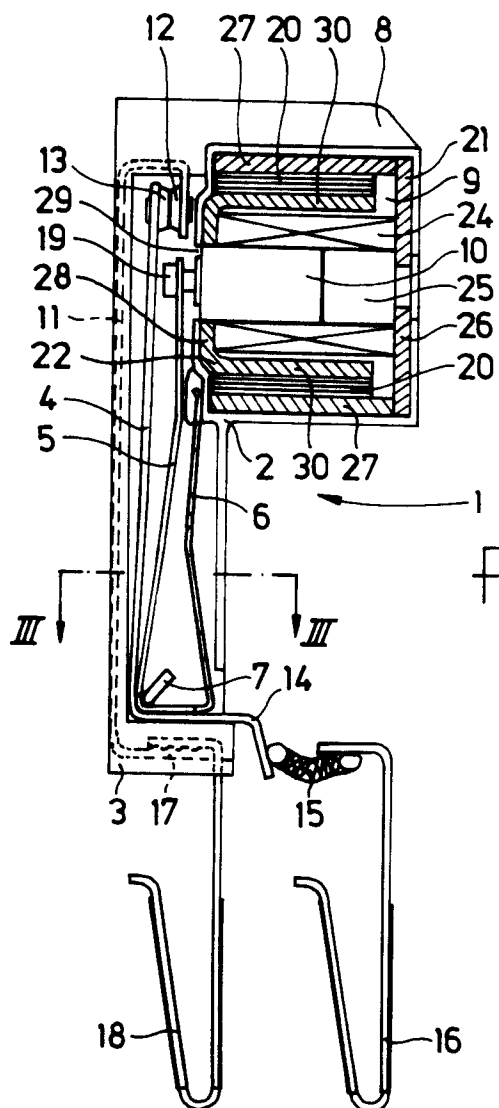
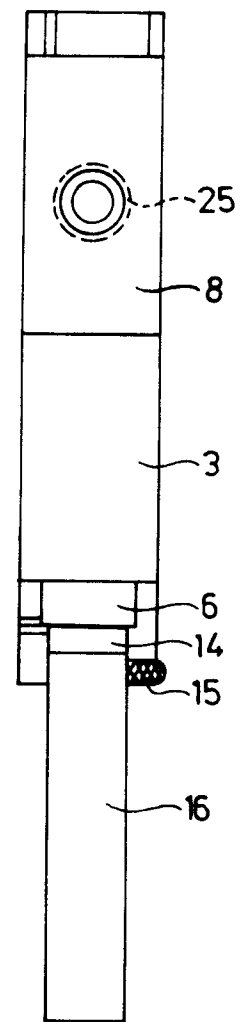
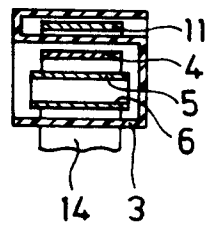


fig - 3



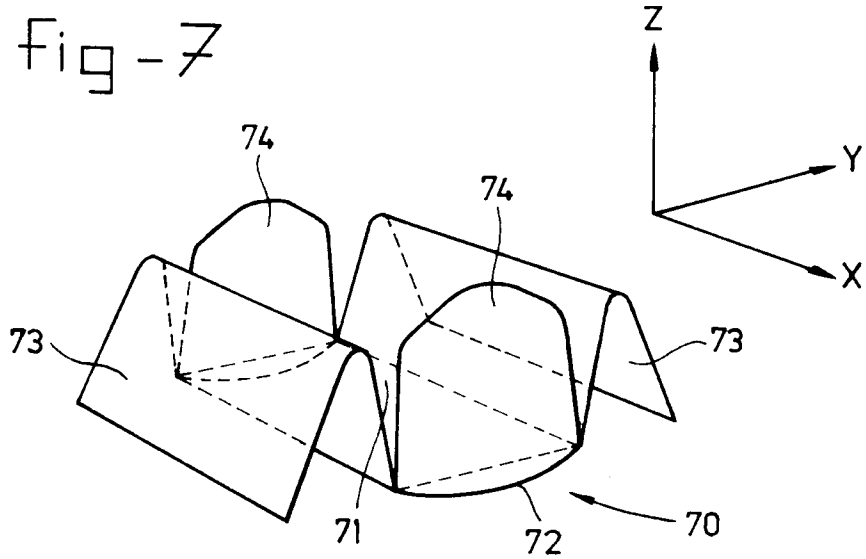
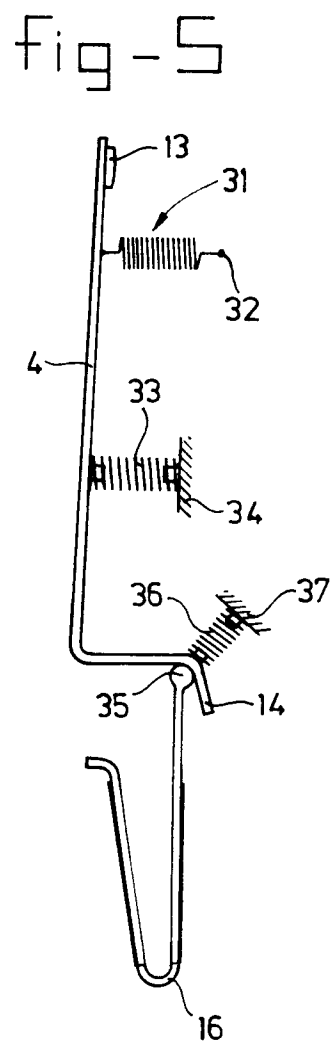
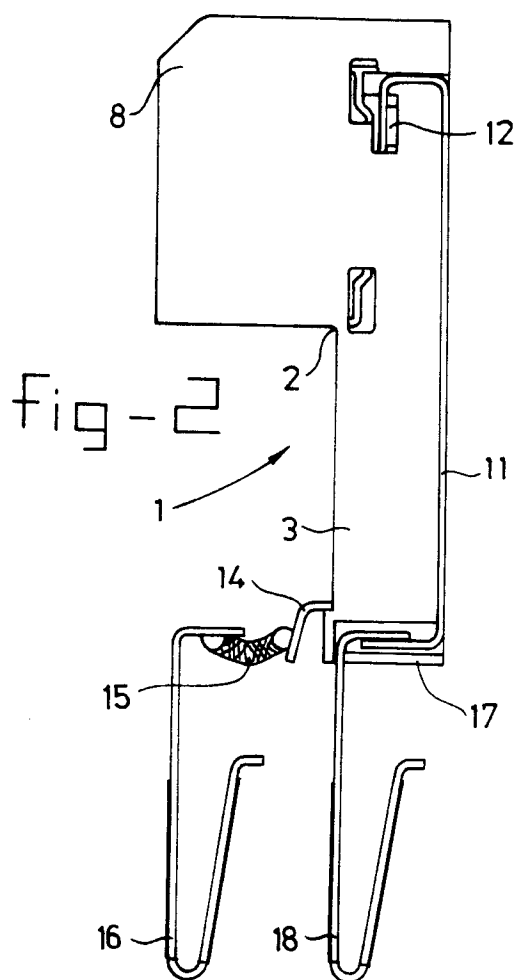


fig - 6

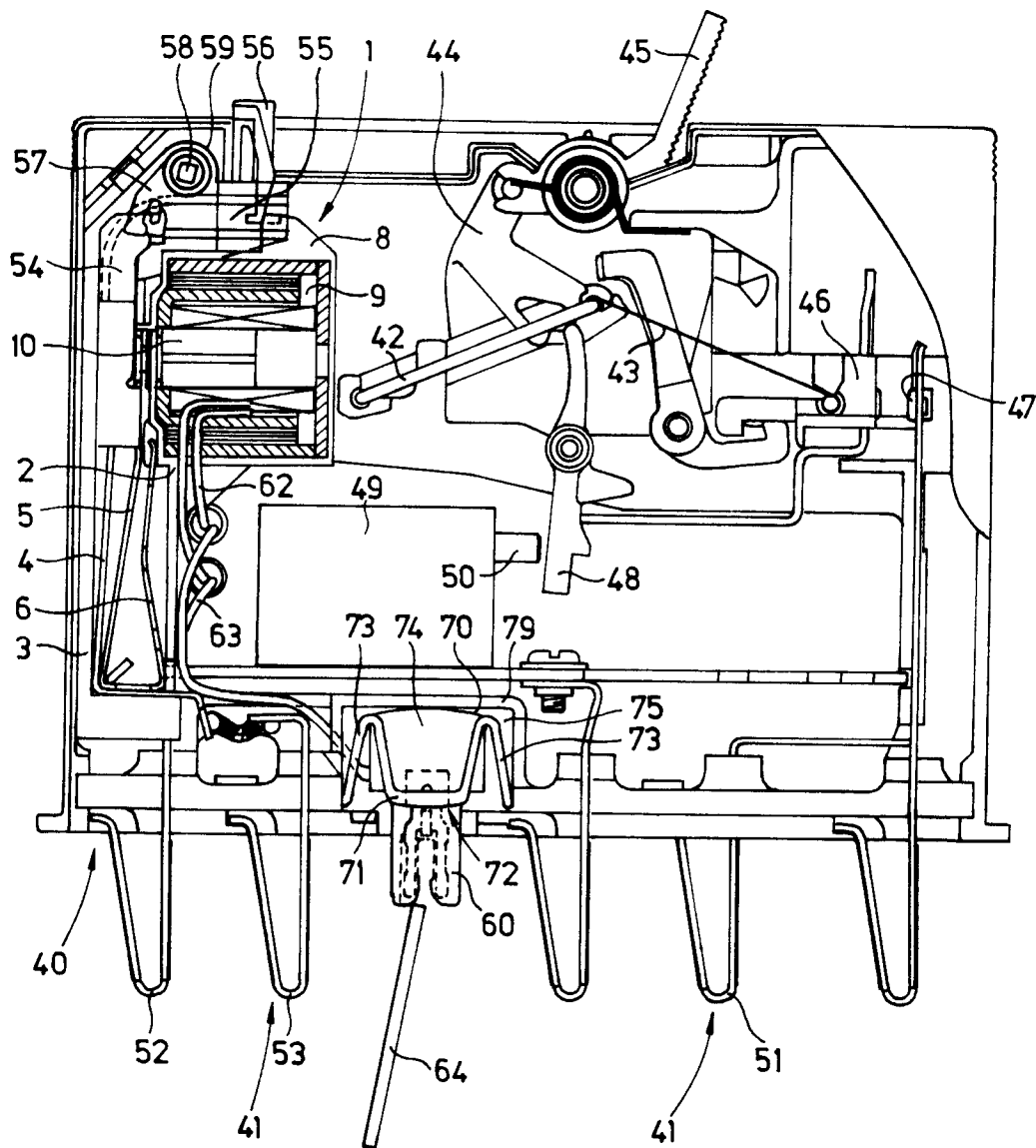


fig - 8

