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(54) **TAMPERING SAFE BI-STABLE RELAY FOR HIGH CURRENTS**

MANIPULATIONSSICHERES BISTABLES RELAIS FÜR HOHE STRÖME

RELAIS BISTABLE INVOLABLE POUR COURANTS ÉLEVÉS

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EP-A2- 0 534 572 WO-A1-95/05671
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Description

FIELD OF THE INVENTION

[0001] The invention relates to the field of electric relays, especially bi-stable relays for connecting or disconnecting the supply of power with a high degree of immunity against magnetic tampering. Further, the invention relates to an electricity meter with such bi-stable relay.

BACKGROUND OF THE INVENTION

[0002] In an electricity distribution net supplying energy to a number of consumers, the electric energy provider needs to be able to disconnect the power line to individual consumers for a short or long period of time, e.g. in case a consumer does not pay the charges to the electric energy provider. In order to disconnect a consumer, it has been common to send an operator to the consumer and manually disconnect the power line to the consumer. However, this is an inconvenient and expensive solution.

[0003] Thus, different solutions exist to remotely disconnect the power line to a consumer. E.g. relays for disconnecting the power line can be mounted in the consumer's electricity meter, wherein the relay is wirelessly controllable or controllable via a high frequency control signal transmitted via the power line. With such solutions, the provider can disconnect and re-connect the consumer in an easy way.

[0004] However, normal relays are based on electromagnetic actuation. Therefore, if the relay is mounted such that it is available for the consumer, e.g. if mounted inside the consumer's electricity meter, such relay may malfunction in case it is exposed to a tampering, e.g. by applying a strong magnetic field, where the consumer can block the relay such that it is impossible for the provider to disconnect his power line.

[0005] Examples of bi-stable relays can be found in e.g. EP2654063A1, DE102012203961B3, and EP3021341A1.

[0006] The document EP 0 534 572 A2 discloses a bi-stable electrical relay comprising a first contact coupled to a movably mounted arm a second contact coupled to an immovably mounted further arm. To operate the contacts, electromagnetic drive means are provided which act on the movable arm via spring means for producing contact force. To keep the contacts closed, the drive means are provided with permanent magnets while further spring means act on the movable arm to keep the contacts open.

SUMMARY OF THE INVENTION

[0007] Thus, according to the above explanation, it is an object of the present invention to provide a relay arranged to connect or break electric energy supply from a power line. The relay should preferably be able to function reliably also in a strong magnetic field applied exter-

nally, so as to be able to resist magnetic tampering. Further, the relay should preferably be capable of handling currents of at least 50 A.

[0008] In a first aspect, the invention provides a bi-stable relay arranged for electrically connecting first and second electrical terminals in a first stable state and for electrically disconnecting said electrical terminals in a second stable state, the relay comprising

- 10 - first and second electrical contact members in electrical contact with the respective first and second electrical terminals, and having respective electrical contact points arranged for providing electrical contact in the first stable state,
- 15 - a slider having a magnetically conducting armature, wherein the slider is arranged to move a distance between first and second stable positions, wherein the slider is arranged to engage with at least one of the first and second electrical contact members so as to break electrical contact between the first and second electrical contact members, when the slider is in the second stable position, and wherein contact points of the first and second electrical contact members are arranged to be in electrical contact, when the slider is in the first stable position,
- 20 - a permanent magnet arranged together with at least a first magnetically conducting element for generating a magnetic flux serving to magnetically attract the armature of the slider, so as to keep the slider in the second stable position,
- 25 - a first spring arrangement arranged to provide a force on the slider, so as to keep the slider in the first stable position irrespective of the magnetic flux generated by the permanent magnet, and
- 30 - an electromagnet comprising at least one electrical coil for receiving an electric input, wherein the electromagnet is arranged to magnetically attract said armature, via the first magnetically conductive element, in response to said electric input, so as to move the slider from the first to the second stable position,
- 35 - and wherein the electromagnet is arranged to magnetically counteract the magnetic flux generated by the permanent magnet in response to said electric input, so as to allow the first spring arrangement to move the slider from the second to the first stable position.
- 40
- 45

[0009] Such relay is advantageous, since it significantly reduces the risk of magnetic tampering due to the use of a combination of a permanent magnet and an electromagnet. In the second stable state, i.e. the disconnected state, the permanent magnet can provide the force to keep the relay disconnected, thereby providing a closed loop magnetic flux path provided by the permanent magnet, preferably stationary, the first magnetically conducting element, preferably also stationary, and the armature of the slider. By a closed magnetic flux path is understood that all of the elements forming the magnetic flux path

are connected in a loop without any significant air gap between them. Even by a rather small and weak permanent magnet, it is hereby possible to ensure a fixing force on the slider, keeping the relay in the second stable state, and which is extremely difficult to manipulate with an external magnetic field. At the same time, the electrically conducting members can easily be formed to withstand high currents by different means for counteracting repelling Lorentz forces which can force the electrically conducting members out of contact in case of large currents. **[0010]** Thus, the relay according to the invention is highly suited for use in electric consumption meters for connecting or disconnecting a consumer to an electric power net.

[0011] The electromagnet is used to bring the relay from the second stable state to the first stable state, i.e. to provide a force opposite to the fixing force provided by the permanent magnet, thereby bringing the slider in a position where the armature does no longer provide a closed magnetic flux path with the permanent magnet, and thus the fixing force of the permanent magnet is significantly reduced. When brought into the first stable state by the electromagnet, the slider is kept in the stable position by the first spring arrangement. It is to be understood that the first spring arrangement should be selected such that it provides a force which can be counteracted by the permanent magnet, when the slider is in the second stable state.

[0012] Further, the relay according to the first aspect is advantageous, since it allows a design of a slider which is completely decoupled from the current conducting elements, thereby making the relay suitable for multi-phase meters where two or more contact pairs are present and manufacturing tolerances make it difficult to control the individual positions precisely, if not decoupled.

[0013] In the following, preferred embodiments or features will be described.

[0014] Since the permanent magnet and the electromagnet share the first magnetically conductive element in order to serve their magnetic function in relation to the armature of the slider, it is possible to obtain a compact and low cost design with rather few components. Especially, the magnetically conductive elements may be formed by a number of flat steel pieces. Especially, the magnetic path can be formed by simple components, e.g. comprising: first and second magnetically conductive elements both being L-shaped, the armature being I-shaped, and only one single permanent magnet is arranged between the first and second magnetically conductive elements. Especially, the coil(s) of the electromagnet may be kept in place in a sandwich assembly, where the permanent magnet holds the assembly together.

[0015] The permanent magnet of the invention has a low magnetic reluctance, so as to allow the above-mentioned shared use of the first magnetically conductive element together with the electromagnet. Especially, such low reluctance can be obtained by large surfaces

between the permanent magnet and adjacent magnetically conductive element(s). In preferred embodiments, the magnetic reluctance of the permanent magnet may especially be lower than $5 \cdot 10^6 \text{ H}^{-1}$, and this may be obtained by a thin permanent magnet, such as having a thickness of 0,5-5 mm, preferably 1-4 mm, seen in a direction of the magnetic path through the permanent magnet. The magnetic resistance of the permanent magnet will reduce the effect of the electromagnet, due to the shared first magnetically conducting element, and thus the magnetic reluctance of the permanent magnet is preferably as low as practically possible.

[0016] The first spring arrangement may comprise a blade spring.

[0017] Preferably, a second spring arrangement, e.g. comprising a blade spring, serves to force the contact points of the first and second electrical contact members together in the first stable state. The force applied by the spring arrangement serves to keep the electrically conducting members in the first stable state until pushed out of contact by the slider.

[0018] Preferably, the at least one electrical coil of the electromagnet is wound around a part of the first magnetically conductive element. Hereby, the first magnetically conductive element serves as a core material for the electromagnet. In this way, the permanent magnet and the electromagnet share the first magnetically conductive element as part of their magnetic circuit for attracting the armature, and with the function of the electromagnet, an efficient counteracting or cancelling the magnetic effect of the permanent magnet can be obtained.

[0019] The electromagnet may have one single coil only which is arranged to receive an electric input current to magnetically attract said armature, and being arranged to receive an opposite electric input current to magnetically counteract the permanent magnet. Alternatively, or additionally, the electromagnet may have at least two coils, wherein one coil is arranged to receive an electric input current so as to magnetically attract said armature, and wherein another coil is arranged to receive an electric input current so as to magnetically counteract the permanent magnet. Using only one coil, a simple design can be obtained, whereas this implementation requires two different DC input signals, so as to generate opposite currents depending on the electromagnet being used to switch from the first to the second stable state or vice versa. This can be avoided using two (or more) coils, where the same DC input signal can be applied to one coil to switch in one direction, while the DC input signal can be applied to another coil to switch the opposite direction.

[0020] The permanent magnet, the at least one coil, and the first magnetically conducting element are preferably mounted in a fixed position relative to the first and second electrical terminals, e.g. all of these elements may be mounted fixed to an electrically non-conducting part of a casing or housing. The slider is preferably ar-

ranged to translate in relation to the casing or housing, so as to switch between its first and second stable positions.

[0021] The slider is preferably decoupled from the first and second electrical contact members, at least in the first stable state. This helps to relax the requirement for manufacturing tolerances, especially in embodiments where the slider has a plurality of engaging parts to be used for simultaneously engaging with a plurality of sets of electrically conducting member pairs, e.g. for simultaneously connecting or disconnecting separate phases of an AC power line. The slider preferably has a slider structure which is electrically non-conducting.

[0022] The first and second electrical contact members may be shaped and arranged so in relation to each other, that their electrical contact points are pressed against each other due to a Lorentz force acting on at least part of the first and second electrical contact members upon conducting an electric current between the first and second electrical terminals. Hereby, it is ensured that Lorentz forces serve to provide a good electrical contact between the electrically conducting members when exposed to high currents, e.g. in case of a short-circuiting, and this helps to prevent possible damage to the electrically conducting members or surrounding parts. Further, the "on" resistance of the relay is lowered, and thereby wear on the contact points is also reduced. Especially, the first and second electrical contact members comprise respective elongate portions arranged parallel or substantially parallel to each other, so as to provide said Lorentz force. Preferably, this is combined with the second electrical contact member having its contact point positioned on a bend portion extending perpendicular to the elongate portion in a direction towards the first electrical contact member, and with a length allowing the contact point to reach electrical with the contact point on the first electrical contact member, wherein the contact point on the first electrical contact member is positioned on a side of the first electrical contact member facing away from the elongate portion of the second electrical contact member. Hereby, the contact points will be forced together by the Lorentz force acting on the elongate portions of the first and second electrical contact members.

[0023] In a special embodiment, the first electrical contact member has its contact point arranged at an end part of its elongate portion, and wherein the second electrical contact member has its contact point positioned at an end part of its elongate portion, wherein said end part is folded or bent around the end part of the elongate portion of the first electrical contact member, so that the contact point of the second electrical member will be forced against the contact point of the first electrical contact member due to the Lorentz force acting on the elongated portions of the contact members.

[0024] Some embodiments may comprise a second set of two electrical contact members in electrical contact with respective two electrical terminals, and wherein the slider is arranged to engage with one of said two electrical

contact members, so as to break electrical contact between the two electrical contact members, when the slider is in the second stable position. Thus, one single slider arrangement can be used for manipulating several sets of electrical contact members.

[0025] The slider may be arranged to translate a distance of 1-20 mm, preferably a distance of 2-10 mm, between its first and second stable positions.

[0026] By a 'power line' or 'electric power line' is understood an electric cables for handling currents of 50 A or more, e.g. as in a public electric network for delivering electrical energy to consumers, such as in dwellings or enterprises.

[0027] In a second aspect, the invention provides an electricity meter for measuring an amount of electrical energy delivered by an electric power line, the meter comprising

- a bi-stable relay according to the first aspect.

[0028] Especially, in such meter, the bi-stable relay may be arranged to electrically connect the electric power line in its first stable state and arranged to electrically disconnect the electric power line in its second stable state, and wherein the meter comprises a communication module arranged to receive a control signal from a remote transmitter and to accordingly switch the bi-stable relay from its first to its second state or vice versa, so as to allow remote control of a consumers access to delivery of electric energy from the electric power line.

[0029] In preferred embodiments, the meter includes a casing, e.g. a closed casing, for housing the measuring device, the bi-stable relay, and the communication module. Parts of the relay may be directly mounted on the casing.

[0030] The meter preferably comprises a measuring device arranged to measure the amount of electric energy delivered by the electric power line, and to generate a data value representing the measured amount of electric energy.

[0031] The meter may include a plurality of relays according to the first aspect, or one relay with a plurality of separate electrical terminals, arranged to disconnect respective electric phases, e.g. three phases, of the power line in response to the control signal. These may be actuated by one common slider or by respective sliders. Especially, the meter may include a relay according to the first aspect arranged to disconnect a neutral conductor of the power line in response to the control signal.

[0032] The communication module may further be arranged to transmit the data value representing the measured amount of electric energy to an associated external receiver. Especially, the communication module may further be arranged to transmit data representing an actual state of the power line switch to an associated external receiver, thus indicating e.g. to a provider that a requested disconnection has actually taken place. The communication module may be arranged to communicate via

one or more of: wireless Radio Frequency signals, the electric power line itself, and/or a dedicated communication wire.

[0033] In a third aspect, the invention provides a supply system for supply of electric energy to a plurality of associated consumers via a net of electric power lines, the system including a plurality of electricity meters according to embodiments of the second aspect. Preferably, these electricity meters include respective communication modules arranged to receive respective control signals from an associated external transmitter, wherein the meters being arranged to disconnect respective electric power lines supplying electric energy to each of the associated consumers upon receiving respective control signals by controlling the bi-stable relays according to the control signals, and - a transmitter arranged to transmit respective control signals to the plurality of electricity meters so as to disconnect electric energy supply to the respective associated consumers.

[0034] With such supply system an electricity provider can remotely and still reliably control connection and disconnection of individual consumers connected to the electrical supply net.

[0035] It is appreciated that any sub aspect mentioned in connection with the first aspect may in any way be combined with any of the sub aspects of the second and third aspect.

BRIEF DESCRIPTION OF DRAWINGS

[0036] In the following, the invention will be described in more details by referring to embodiments illustrated in the accompanying drawings, of which

Fig. 1 illustrates a relay embodiment with three electrical contact sets and being in the first bi-stable state, i.e. with the electrical contacts in connected state,

Fig. 2 illustrates for the same embodiment as in Fig. 1, but in the second bi-stable state, i.e. with the electrical contacts in disconnected state,

Fig. 3 illustrates, still for the same embodiment as in Fig. 1, but where the relay in a middle position between the first and second bi-stable states,

Figs. 4a-4d illustrate the function of the slider arrangement, the permanent magnet and electromagnets in different states of the bi-stable relay, and

Fig. 5 illustrates a 3D view of one implementation of the electrical contact members, and

Fig. 6 illustrates an embodiment of the bi-stable relay mounted in an electric consumption meter housing.

DETAILED DESCRIPTION OF THE INVENTION

[0037] Fig. 1 illustrates a bi-stable relay embodiment with three identical electrical contact sets C1, C2, C3 actuated by one single slider SL. In Fig. 1, the relay is in the first stable state, i.e. with the contact sets C1, C2, C3 in the connected state.

[0038] This relay embodiment is suitable for forming part of a three-phase electric consumption meter. In the following, only the first contact set C1 will be described.

[0039] First and second electrical contact members CM1, CM2 are in electrical contact with the respective electrical terminals T1, T2 where power line cables can be connected. These electrical contact members CM1, CM2 have respective electrical contact points CP1, CP2, implemented in this embodiment as rivets, arranged for providing electrical contact in the first stable state of the relay, i.e. the state of the relay shown in Fig. 1. The first electrical contact member CM1 is fixed, whereas the second electrical contact member CM2 is flexible, such that it can bend upon mechanical activation to provide electrical contact between the contact points CP1, CP2.

[0040] A slider SL is arranged to engage with the second electrical contact member CM2. The slider SL has a slider structure SLS, e.g. made of a polymer, and the slider structure SLS is in fixed connection with a magnetically conducting armature AM. The slider SL is arranged to translate a distance between first and second stable positions. Directions of translation is indicated by the bold double arrow. In Fig. 1, the slider SL is in its first stable position, i.e. it is in its position to the right in relation to the fixed parts of the relay. The slider SL has a protruding engagement portion SE arranged to push the second contact member CM2, when the slider SL is in its second stable position, i.e. to the left. In Fig. 1, the engagement portion SE is seen to be out of engagement with the second contact member CM2, and thus the slider SL is completely decoupled from any contact with the contact members CM1, CM2 in the first stable state of the relay.

[0041] A blade spring S2 acts on the end portion of the second contact member CM2, so as to force it to apply a force to bend it into electric contact with the first contact member CM1, which has a fixed position. In the first stable state, Fig. 1, the contact points CP1, CP2 are seen in contact with each other, thus providing electrical contact between the first and second electrical terminals T1, T2. The contact members CM1, CM2 can be made of any known in the art, e.g. copper.

[0042] The slider SL movement is actuated by a combination of a permanent magnet PM arranged in this embodiment between first and second L-shaped magnetically conducting elements ML1, ML2, and an electromagnet EM with one or more electrical coil(s) for receiving an electric input for changing between the two stable states of the relay. The two L-shaped magnetically conductive elements ML1, ML2 form part of a magnetic path for magnetically attracting the armature AM of the slider SL, as well as forming part of a magnetic path for either

attracting the armature or for counteracting the magnetic flux generated by the permanent magnet and thus releasing or cancelling magnetic attraction of the armature AM of the slider SL. To obtain such combined use of the electromagnet EM and the permanent magnet PM forming part of the magnetic path, it is preferred that the magnetic reluctance of the permanent magnet PM is low, since sharing the same magnetic path including the permanent magnet PM, the electromagnet EM will have to overcome the magnetic reluctance of the permanent magnet PM. This can be obtained by selecting a rather thin permanent magnet, e.g. the permanent magnet PM having a length of 1-5 mm, seen in the view of Fig. 1. This has been found to be sufficient to provide the required magnetic strength of the permanent magnet PM, and to provide a reasonably low magnetic resistance to ensure an efficient function of the electromagnet EM.

[0043] In the first stable state, Fig. 1, the slider SL is pushed into its first stable position by a blade spring S1 acting on the slider structure SLS, thereby providing an air gap between the two L-shaped magnetically conductive elements ML1, ML2 and the armature AM of the slider SL. This air gap is designed along with the spring force of the blade spring S1, and the magnetic power of the permanent magnet PM, such that the spring force of the blade spring S1 exceeds the magnetic attraction force provided by the permanent magnet PM on the armature AM in the first stable position of the slider SL.

[0044] The permanent magnet PM, the coil(s) of the electromagnet EM, and the magnetically conducting elements ML1, ML2 are mounted in a fixed position, i.e. stationary, relative to the electrical terminals T1, T2. The function of the electromagnet EM for changing between the stable states of the relay will be explained below.

[0045] The magnetically conducting elements ML1, ML2 and the armature AM can be made of various ferromagnetic or ferrimagnetic material such as iron or steel plates, thereby allowing a low cost magnetic circuit.

[0046] Fig. 2 shows the same relay as in Fig. 1, but here in the second stable state, i.e. with the slider SL being in its second stable state. Hereby, the engaging protruding part SE of the slider SL pushes the second electrical conducting member CM2 to bend, such that electrical contact between the electrical contact members CM1, CM2 is disconnected. In this second stable state, the permanent magnet PM, the magnetically conducting elements ML1, ML2 and the armature AM of the slider SL form a closed magnetic flux path, since the magnetically conducting elements ML1, ML2 and the armature AM are in contact, and thus the permanent magnet PM generates a magnetic flux serving to magnetically attract the armature AM of the slider SL, so as to keep the slider SL in its second stable position. Since a closed magnetic flux path loop is hereby provided to keep the relay fixed in the second stable state, i.e. disconnected, external magnetic tampering attempts to make the relay switch back to the first stable state is made highly difficult. By a closed magnetic flux path is understood a magnetic

flux path loop without any significant air gaps between the magnetically conducting components forming the magnetic flux path.

[0047] Fig. 3 shows the relay of Figs. 1 and 2, but here with the slider SL is in a middle position between its stable positions, and thus with the relay between its stable states. As seen, the closed loop magnetic path between the permanent magnet PM, the magnetically conducting elements ML1, ML2 and the armature AM is broken by an air gap between the magnetically conducting elements ML1, ML2 and the armature AM, and thereby the magnetic attraction force provided by the permanent magnet PM is highly reduced.

[0048] Figs. 4a-4c serve to illustrate the function of the slider SL and magnetic actuating elements PM, EM, ML1, ML2, AM in different states and transitions of the relay, thereby explaining how energizing the coil(s) of the electromagnet EM can change from the first to the second stable state of the relay, or vice versa. This illustrates with the same slider SL arrangement and actuating elements PM, EM, ML1, ML2, AM as in Figs. 1-3. Magnetic poles are indicated by n and s for exemplary purposes and may be reversed as envisaged by the skilled person.

[0049] In Fig. 4a, the slider SL is in its first stable position, and the blade spring S1 (see Fig. 1) pushes the slider SL with a force exceeding the opposite magnetic force provided by the permanent magnet PM which, via an air gap, serves to attract the armature AM.

[0050] In Fig. 4b, the slider SL is still in its first stable position, but an electric input is applied to the electromagnet EM which accordingly creates a magnetic flux with the same polarity as the permanent magnet PM, and magnetically attracts the armature AM with a force serving to exceed the opposite force from the blade spring S1 on the slider SL, and hereby moving the slider SL from its first stable position to its second stable position.

[0051] In Fig. 4c, the slider SL has reached its second stable position, i.e. where the relay is electrically disconnected. The electric input to the electromagnet EM has been switched off, and the permanent magnet PM provides a closed magnetic flux path together with the magnetically conducting elements ML1, ML2 and the armature AM, since the magnetically conducting elements ML1, ML2 and the armature AM are in contact. Hereby, the rather weak permanent magnet PM can generate a magnetic flux serving to magnetically attract the armature AM of the slider SL, so as to keep the slider SL in its second stable position irrespective of the opposite force from the blade spring S1 on the slider SL.

[0052] In Fig. 4d, the slider SL is still in its second stable position, but an electric input is applied to the electromagnet EM, such that it creates a magnetic flux with opposite polarity of the permanent magnet PM, thereby counteracting or cancelling the magnetic flux generated by the permanent magnet PM, such that the attraction force on the armature AM is released. Thereby, the spring S1, see Figs. 1-3, will push the slider SL from its second to its first stable position.

[0053] The electromagnet or solenoid EM can have a single coil, where opposite magnetic actions from the electromagnet EM can be obtained by applying opposite electric currents to the coil, or by using a second coil. The permanent magnet PM keeps the steel magnetically conducting elements ML1, ML2 together, and the coil(s) of the electromagnet EM are wound around the assembly/core/sandwich construction, i.e. the coil(s) are preferably wound around part of the magnetically conducting elements ML1, ML2, either around one or both of the magnetically conducting elements ML1, ML2. The coil(s) are thus kept in place by the geometry of the magnetically conducting elements ML1, ML2 but also aid to keep the construction together. The permanent magnet PM used in the sandwich construction should advantageously be as small as possible to reduce the negative effects of the permanent magnet PM on the magnetic field created by the electromagnet EM. Seen from the magnetic path of the electromagnet EM, the permanent magnet PM has a magnetic reluctance similar to air. Thus, the permanent magnet PM reduces the forces created by the electromagnet EM to attract the armature AM. By using a permanent magnet PM which is small, it is possible to use a single steel path/core ML1, ML2 for moving the slider SL in both directions between the conducting- and broken states, respectively.

[0054] Fig. 5 illustrates a 3D sketch of the electrical contact members CM1, CM2 from Figs. 1-3. These electrical contact members CM1, CM2 are shaped and arranged so in relation to each other, such that their electrical contact points CP1, CP2, e.g. in the form of rivets, are pressed against each other due to a Lorentz force acting on elongate portions CE1, CE2 of the contact members CM1, CM2, when an electric current is conducted through these elongate portions CE1, CE2 between the electrical terminals T1, T2. The elongate portions CE1, CE2, e.g. 10-60 mm long, are arranged parallel or substantially parallel to each other, and thus the Lorentz force will provide a repelling between them. However, the contact points CP1, CP2 will be forced together due to the Lorentz force, because the first electrical contact member CM1 has its contact point CP1 arranged at an end part of its elongate portion CE1, and the second electrical contact member CM2 has its contact point CP2 positioned at an end part B of its elongate portion CE2, and this end part B is folded or bent around the end part of the elongate portion CE1 of the first electrical contact member CM1. This means that the contact points CP1, CP2 will be forced together in case of a high current, e.g. a short-circuit current, and thereby the relay is suited for high current applications without problems with wear or damage due to arcs or sparks when used for high currents.

[0055] It is to be understood that alternative implementations can be used to obtain the same effect, i.e. that Lorentz forces serving to repel parallel or substantially parallel elongate portions of the electrical conducting members, and where at least one of the electrical con-

ducting members has its contact point positioned on a bend portion extending perpendicular to its elongate portion. This bend portion can be positioned at other part of the elongate portion than the end part. E.g. the bend portion can be positioned midway between base part and end part of the elongate portion, or at another position between base part and end part of the elongate portion.

[0056] Fig. 6 shows the relay R of Figs. 1-3 mounted in the housing H of an electric consumption meter. The relay is suited for integration in such meter, since it allows remote control of delivery of electric energy to each individual consumer in an electric distribution net. Especially, the relay can be operated remotely via the same communication module which is also used for remote reading of the meter.

[0057] To sum up, the invention provides a bi-stable electric relay. Electrical contact members CM1, CM2 are in contact with the respective electrical terminals T1, T2. The contact members CM1, CM2 provide electric contact in the first stable state, and are disconnected in the second stable state. A slider SL with a magnetically conducting armature AM can move between two stable positions and the slider SL can thereby break electrical contact between the contact members CM1, CM2 in one stable position. A permanent magnet PM arranged with a magnetically conducting element ML1, ML2 for generating a magnetic flux to magnetically attract the armature AM of the slider SL, so as to keep the slider SL in the stable position, where the contact members CM1, CM2 are disconnected. An electromagnet EM or solenoid, preferably sharing the magnetically conducting element ML1, ML2 with the permanent magnet PM, is used to switch between the stable states by being energized by an electric current to either attract the armature AM of the slider SL or to cancel the attraction force provided by the permanent magnet. The electromagnet EM should be powerful enough to counteract the magnetic attraction force of the permanent magnet PM in the disconnected state. The contact members CM1, CM2 are designed such that repelling Lorentz forces serve to force their electric contact points against each other, thereby allowing the relay to be used for high currents without damage problems. The relay can be integrated in an electricity meter to allow remote breaking of delivery of electric energy to a consumer.

Claims

1. A bi-stable relay arranged for electrically connecting first and second electrical terminals (T1, T2) in a first stable state and for electrically disconnecting said electrical terminals (T1, T2) in a second stable state, the relay comprising
 - first and second electrical contact members (CM1, CM2) in electrical contact with the respective first and second electrical terminals (T1, T2),

and having respective electrical contact points (CP1, CP2) arranged for providing electrical contact in the first stable state,

- a slider (SL) having a magnetically conducting armature (AM), wherein the slider (SL) is arranged to move a distance between first and second stable positions, wherein the slider (SL) is arranged to engage with at least one of the first and second electrical contact members (CM1, CM2) so as to break electrical contact between the first and second electrical contact members (CM1, CM2), when the slider (SL) is in the second stable position, and wherein contact points (CP1, CP2) of the first and second electrical contact members (CM1, CM2) are arranged to be in electrical contact, when the slider (SL) is in the first stable position,

- a permanent magnet (PM) arranged together with at least a first magnetically conducting element (ML1, ML2) for generating a magnetic flux serving to magnetically attract the armature (AM) of the slider (SL), so as to keep the slider (SL) in the second stable position,

- a first spring arrangement (S1) arranged to provide a force on the slider (SL), so as to keep the slider (SL) in the first stable position irrespective of the magnetic flux generated by the permanent magnet (PM), and

- an electromagnet (EM) comprising at least one electrical coil for receiving an electric input, wherein the electromagnet (EM) is arranged to magnetically attract said armature (AM), via the first magnetically conductive element (ML1, ML2), in response to said electric input, so as to move the slider (SL) from the first to the second stable position, and wherein the electromagnet (EM) is arranged to magnetically counteract the magnetic flux generated by the permanent magnet (PM) in response to said electric input, so as to allow the first spring arrangement (S1) to move the slider (SL) from the second to the first stable position,

characterised in that the permanent magnet (PM) has a low magnetic reluctance, so as to allow the permanent magnet (PM) to form part of a magnetic path of the electromagnet (EM) together with the first magnetically conductive element (ML1, ML2).

2. The bi-stable relay according to any of claim 1, wherein the permanent magnet (PM), the first magnetically conducting element (ML1, ML2) and the armature (AM) form a closed magnetic flux path in the second stable state.
3. The bi-stable relay according to claim 2, wherein the permanent magnet (PM) is arranged between first and second L-shaped magnetically conducting ele-

ments (ML1, ML2), and wherein the permanent magnet (PM), the first and second magnetically conducting elements (ML1, ML2) and the armature (AM) form a closed magnetic flux path in the second stable state.

4. The bi-stable relay according to any of the preceding claims, wherein the electromagnet (EM) has one single coil arranged to receive an electric input current to magnetically attract said armature (EM), and being arranged to receive an opposite electric input current to counteract the magnetic flux generated by the permanent magnet (PM).
5. The bi-stable relay according to any of the claims 1-3, wherein the electromagnet (EM) has two coils, wherein one coil is arranged to receive an electric input current so as to magnetically attract said armature (AM), and wherein another coil is arranged to receive an electric input current so as to counteract the magnetic flux generated by the permanent magnet (PM).
6. The bi-stable relay according to any of the preceding claims, wherein the permanent magnet (PM), the at least one coil, and the first magnetically conducting element (ML1, ML2) are mounted in a fixed position relative to the first and second electrical terminals (T1, T2).
7. The bi-stable relay according to any of the preceding claims, wherein the slider (SL) is decoupled from the first and second electrical contact members (CM1, CM2) at least in the first stable state.
8. The bi-stable relay according to any of the preceding claims, comprising a second spring arrangement (S2) serving to force the contact points (CP1, CP2) of the first and second electrical contact members (CM1, CM2) together in the first stable state.
9. The bi-stable relay according to any of the preceding claims, wherein the first and second electrical contact members (CM1, CM2) are shaped and arranged so in relation to each other, that their electrical contact points (CP1, CP2) are pressed against each other due to a Lorentz force acting on at least part of the first and second electrical contact members (CM1, CM2) upon conducting an electric current between the first and second electrical terminals (T1, T2).
10. The bi-stable relay according to claim 9, wherein the first and second electrical contact members (CM1, CM2) comprise respective elongate portions (CE1, CE2) arranged parallel or substantially parallel to each other, so as to provide said Lorentz force.

11. The bi-stable relay according to any of the claims 9 or 10, wherein the first electrical contact member (CM1) has its contact point (CP1) arranged at an end part of its elongate portion (CE1), and wherein the second electrical contact member (CM2) has its contact point (CP2) positioned at an end part (B) of its elongate portion (CE2), wherein said end part (B) is folded or bent around the end part of the elongate portion (CE1) of the first electrical contact member (CM1), so that the contact point (CP2) of the second electrical contact member (CM2) will be forced against the contact point (CP1) of the first electrical contact member (CM1) due to the Lorentz force acting on the elongated portions (CE1, CE2) of the contact members (CM1, CM2).
12. The bi-stable relay according to any of the preceding claims, comprising a second set of two electrical contact members in electrical contact with respective two electrical terminals, and wherein the slider (SL) is arranged to engage with one of said two electrical contact members, so as to break electrical contact between the two electrical contact members, when the slider (SL) is in the second stable position.
13. An electricity meter for measuring an amount of electrical energy delivered by an electric power line, the meter comprising a bi-stable relay (R) according to any of claims 1-12.
14. The electricity meter according to claim 13, wherein the bi-stable relay is arranged to electrically connect the electric power line in its first stable state and being arranged to electrically disconnect the electric power line in its second stable state, and wherein the meter comprises a communication module arranged to receive a control signal from a remote transmitter, and to accordingly switch the bi-stable relay from its first to its second state or vice versa, so as to allow remote control of a consumers access to delivery of electric energy from the electric power line.

Patentansprüche

1. Bistabiles Relais, angeordnet zum elektrischen Verbinden eines ersten und eines zweiten elektrischen Anschlusses (T1, T2) in einem ersten stabilen Zustand und zum elektrischen Trennen der elektrischen Anschlüsse (T1, T2) in einem zweiten stabilen Zustand, wobei das Relais Folgendes umfasst:
- ein erstes und ein zweites elektrisches Kontaktelement (CM1, CM2) in elektrischem Kontakt mit dem jeweiligen ersten und zweiten elektrischen Anschluss (T1, T2), und aufweisend jeweilige elektrische Kontaktpunkte (CP1, CP2),

die zum Bereitstellen von elektrischem Kontakt in dem ersten stabilen Zustand angeordnet sind,

- einen Schieber (SL) mit einer magnetisch leitenden Armatur (AM), wobei der Schieber (SL) dazu angeordnet ist, einen Abstand zwischen einer ersten und einer zweiten stabilen Position zurückzulegen, wobei der Schieber (SL) dazu angeordnet ist, in zumindest eines von dem ersten und dem zweiten elektrischen Kontaktelement (CM1, CM2) einzugreifen, um so elektrischen Kontakt zwischen dem ersten und dem zweiten elektrischen Kontaktelement (CM1, CM2) zu unterbrechen, wenn sich der Schieber (SL) in der zweiten stabilen Position befindet, und wobei die Kontaktpunkte (CP1, CP2) des ersten und des zweiten elektrischen Kontaktelements (CM1, CM2) dazu angeordnet sind, in elektrischem Kontakt zustehen, wenn sich der Schieber (SL) in der ersten stabilen Position befindet,

- einen Dauermagneten (PM), der zusammen mit zumindest einem ersten magnetisch leitenden Element (ML1, ML2) angeordnet ist, zum Erzeugen eines magnetischen Flusses, der dazu dient, die Armatur (AM) des Schiebers (SL) anzuziehen, um so den Schieber (SL) in der zweiten stabilen Position zu halten,

- eine erste Federanordnung (S1), die dazu angeordnet ist, eine Kraft auf den Schieber (SL) anzuwenden, um so den Schieber (SL) unabhängig von dem magnetischen Fluss, der durch den Dauermagneten (PM) erzeugt ist, in der ersten stabilen Position zu halten, und

- einen Elektromagneten (EM), umfassend zumindest eine elektrische Spule zum Empfangen einer elektrischen Eingabe, wobei der Elektromagnet (EM) dazu angeordnet ist, die Armatur (AM) über das erste magnetisch leitende Element (ML1, ML2) als Reaktion auf die elektrische Eingabe magnetisch anzuziehen, um so den Schieber (SL) aus der ersten in die zweite stabile Position zu bewegen, und wobei der Elektromagnet (EM) dazu angeordnet ist, dem magnetischen Fluss, der durch den Dauermagneten (PM) als Reaktion auf die elektrische Eingabe erzeugt wird, magnetisch entgegenzuwirken, um es so der ersten Federanordnung (S1) zu ermöglichen, den Schieber (SL) aus der zweiten in die erste stabile Position zu bewegen,

dadurch gekennzeichnet, dass der Dauermagnet (PM) einen niedrigen magnetischen Widerstand aufweist, um es so dem Dauermagneten (PM) zu ermöglichen, einen Teil eines magnetischen Pfades des Elektromagneten (EM) zusammen mit dem ersten magnetisch leitenden Element (ML1, ML2) zu bilden.

2. Bistabiles Relais nach Anspruch 1, wobei der Dauermagnet (PM), das erste magnetisch leitende Element (ML1, ML2) und die Armatur (AM) einen geschlossenen magnetischen Flusspfad in dem zweiten stabilen Zustand bilden. 5
3. Bistabiles Relais nach Anspruch 2, wobei der Dauermagnet (PM) zwischen dem ersten und dem zweiten L-förmigen, magnetisch leitenden Element (ML1, ML2) angeordnet ist, und wobei der Dauermagnet (PM), das erste und das zweite magnetisch leitende Element (ML1, ML2) und die Armatur (AM) einen geschlossenen magnetischen Flusspfad in dem zweiten stabilen Zustand bilden. 10
4. Bistabiles Relais nach einem der vorhergehenden Ansprüche, wobei der Elektromagnet (EM) eine einzelne Spule aufweist, die dazu angeordnet ist, einen elektrischen Eingabestrom zu empfangen, um die Armatur (EM) magnetisch anzuziehen, und dazu angeordnet ist, einen entgegengesetzten elektrischen Eingabestrom zu empfangen, um dem magnetischen Fluss, der durch den Dauermagneten (PM) erzeugt wird, entgegenzuwirken. 15
5. Bistabiles Relais nach einem der Ansprüche 1-3, wobei der Elektromagnet (EM) zwei Spulen aufweist, wobei eine Spule dazu angeordnet ist, einen elektrischen Eingabestrom zu empfangen, um so die Armatur (AM) magnetisch anzuziehen, und wobei eine weitere Spule dazu angeordnet ist, einen elektrischen Eingabestrom zu empfangen, um so dem magnetischen Fluss, der durch den Dauermagneten (PM) erzeugt wird, entgegenzuwirken. 20
6. Bistabiles Relais nach einem der vorhergehenden Ansprüche, wobei der Dauermagnet (PM), die zumindest eine Spule und das erste magnetisch leitende Element (ML1, ML2) an einer festen Position in Bezug auf den ersten und den zweiten elektrischen Anschluss (T1, T2) befestigt sind. 25
7. Bistabiles Relais nach einem der vorhergehenden Ansprüche, wobei der Schieber (SL) von dem ersten und dem zweiten elektrischen Kontaktelement (CM1, CM2) zumindest in dem ersten stabilen Zustand entkoppelt ist. 30
8. Bistabiles Relais nach einem der vorhergehenden Ansprüche, umfassend eine zweite Federanordnung (S2), die dazu dient, die Kontaktpunkte (CP1, CP2) des ersten und des zweiten elektrischen Kontaktelements (CM1, CM2) zusammen in den ersten stabilen Zustand zu zwingen. 35
9. Bistabiles Relais nach einem der vorhergehenden Ansprüche, wobei das erste und das zweite elektrische Kontaktelement (CM1, CM2) in Bezug zueinander so geformt und angeordnet sind, dass deren elektrische Kontaktpunkte (CP1, CP2) aufgrund einer Lorentz-Kraft, die auf zumindest einen Teil des ersten und des zweiten elektrischen Kontaktelements (CM1, CM2) beim Leiten eines elektrischen Stroms zwischen dem ersten und dem zweiten elektrischen Anschluss (T1, T2) wirkt, gegeneinander gedrückt werden. 40
10. Bistabiles Relais nach Anspruch 9, wobei das erste und das zweite elektrische Kontaktelement (CM1, CM2) jeweilige verlängerte Abschnitte (CE1, CE2) umfassen, die parallel oder im Wesentlichen parallel zueinander angeordnet sind, um so die Lorentz-Kraft bereitzustellen. 45
11. Bistabiles Relais nach einem der Ansprüche 9 oder 10, wobei bei dem ersten elektrischen Kontaktelement (CM1) dessen Kontaktpunkt (CP1) an einem Endteil von dessen verlängertem Abschnitt (CE1) angeordnet ist, und wobei bei dem zweiten elektrischen Kontaktelement (CM2) dessen Kontaktpunkt (CP2) an einem Endteil (B) von dessen verlängertem Abschnitt (CE2) positioniert ist, wobei der Endteil (B) um den Endteil des verlängerten Abschnitts (CE1) des ersten elektrischen Kontaktelements (CM1) gefaltet oder gebogen ist, sodass der Kontaktpunkt (CP2) des zweiten elektrischen Kontaktelements (CM2) durch die Lorentz-Kraft, die auf die verlängerten Abschnitte (CE1, CE2) der Kontaktelemente (CM1, CM2) wirkt, gegen den Kontaktpunkt (CP1) des ersten elektrischen Kontaktelements (CM1) gedrückt wird. 50
12. Bistabiles Relais nach einem der vorhergehenden Ansprüche, umfassend eine zweite Reihe von zwei elektrischen Kontaktelementen in elektrischem Kontakt mit jeweiligen zwei elektrischen Anschlüssen, und wobei der Schieber (SL) dazu angeordnet ist, in eines der zwei elektrischen Kontaktelemente einzugreifen, um so elektrischen Kontakt zwischen den zwei elektrischen Kontaktelementen zu unterbrechen, wenn sich der Schieber (SL) in der zweiten stabilen Position befindet. 55
13. Elektrizitätszähler zum Messen einer Menge von elektrischer Energie, die durch eine Elektrizitätsleitung bereitgestellt ist, der Zähler umfassend ein bistabiles Relais (R) nach einem der Ansprüche 1-12.
14. Elektrizitätszähler nach Anspruch 13, wobei das bistabiles Relais dazu angeordnet ist, die Elektrizitätsleitung in ihrem ersten stabilen Zustand elektrisch zu verbinden, und dazu angeordnet ist, die Elektrizitätsleitung in ihrem zweiten stabilen Zustand elektrisch zu trennen, und wobei der Zähler ein Kommunikationsmodul umfasst, das dazu angeordnet ist, ein Steuersignal von einem entfernten Sender zu

empfangen und um entsprechend das bistabile Relais aus dessen ersten in dessen zweiten Zustand oder umgekehrt zu schalten, um so Fernsteuerung eines Verbraucherzugriffs auf Lieferung von elektrischer Energie aus der Elektrizitätsleitung zu ermöglichen.

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Revendications

1. Relais bistable agencé pour connecter électriquement des première et deuxième bornes électriques (T1, T2) dans un premier état stable et déconnecter électriquement lesdites bornes électriques (T1, T2) dans un deuxième état stable, le relais comprenant

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- des premier et deuxième éléments de contact électrique (CM1, CM2) en contact électrique avec les première et deuxième bornes électriques (T1, T2) respectives, et possédant des points de contact électriques respectifs (CP1, CP2) agencés pour réaliser un contact électrique dans le premier état stable,

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- un curseur (SL) possédant un induit magnétiquement conducteur (AM), le curseur (SL) étant agencé pour se déplacer sur une distance entre des première et deuxième positions stables, le curseur (SL) étant agencé pour s'engager avec au moins un des premier et deuxième éléments de contact électrique (CM1, CM2) de façon à couper un contact électrique entre les premier et deuxième éléments de contact électrique (CM1, CM2), lorsque le curseur (SL) se trouve dans la deuxième position stable, et les points de contact (CP1, CP2) des premier et deuxième éléments de contact électrique (CM1, CM2) étant agencés pour se trouver en contact électrique lorsque le curseur (SL) se trouve dans la première position stable,

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- un aimant permanent (PM) agencé avec au moins un premier élément magnétiquement conducteur (ML1, ML2) pour la génération d'un flux magnétique servant à attirer magnétiquement l'induit (AM) du curseur (SL), de façon à maintenir le curseur (SL) dans la deuxième position stable,

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- un premier ensemble ressort (S1) agencé pour exercer une force sur le curseur (SL) de façon à maintenir le curseur (SL) dans la première position stable, indépendamment du flux magnétique généré par l'aimant permanent (PM), et
- un électroaimant (EM) comprenant au moins une bobine électrique pour recevoir une entrée électrique, l'électroaimant (EM) étant agencé pour attirer magnétiquement ledit induit (AM), via le premier élément magnétiquement conducteur (ML1, ML2), en réponse à ladite entrée électrique, de façon à déplacer le curseur (SL)

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de la première à la deuxième position stable, et l'électroaimant (EM) étant agencé pour contrer magnétiquement le flux magnétique généré par l'aimant permanent (PM) en réponse à ladite entrée électrique, afin de permettre au premier ensemble ressort (S1) de déplacer le curseur (SL) de la deuxième à la première position stable,

caractérisé en ce que l'aimant permanent (PM) présente une faible réluctance magnétique afin de permettre à l'aimant permanent (PM) de faire partie d'un chemin magnétique de l'électroaimant (EM) conjointement avec le premier élément magnétiquement conducteur (ML1, ML2).

2. Relais bistable selon une quelconque des revendications de la revendication 1, l'aimant permanent (PM), le premier élément magnétiquement conducteur (ML1, ML2) et l'induit (AM) constituant un chemin de flux magnétique fermé dans le deuxième état stable.

3. Relais bistable selon la revendication 2, l'aimant permanent (PM) étant agencé entre les premier et deuxième éléments magnétiquement conducteurs en L (ML1, ML2), et l'aimant permanent (PM), les premier et deuxième éléments magnétiquement conducteurs (ML1, ML2) et l'induit (AM) constituant un chemin de flux magnétique fermé dans le deuxième état stable.

4. Relais bistable selon une quelconque des revendications précédentes, l'électroaimant (EM) possédant une bobine individuelle agencée pour recevoir un courant d'entrée électrique afin d'attirer magnétiquement ledit induit (EM), et étant agencé pour recevoir un courant d'entrée électrique opposé pour contrer le flux magnétique généré par l'aimant permanent (PM).

5. Relais bistable selon une quelconque des revendications 1-3, l'électroaimant (EM) possédant deux bobines, une bobine étant agencée pour recevoir un courant d'entrée électrique de façon à attirer magnétiquement ledit induit (AM), et une autre bobine étant agencée pour recevoir un courant d'entrée électrique de façon à contrer le flux magnétique généré par l'aimant permanent (PM).

6. Relais bistable selon une quelconque des revendications précédentes, l'aimant permanent (PM), l'au moins une bobine, et le premier élément magnétiquement conducteur (ML1, ML2) étant montés dans une position fixe relativement aux première et deuxième bornes électriques (T1, T2).

7. Relais bistable selon une quelconque des revendications précédentes, le curseur (SL) étant découplé

- des premier et deuxième éléments de contact électrique (CM1, CM2) au moins dans le premier état stable.
8. Relais bistable selon une quelconque des revendications précédentes, comprenant un deuxième ensemble ressort (S2) servant à forcer les points de contact (CP1, CP2) des premier et deuxième éléments de contact électrique (CM1, CM2) ensemble dans le premier état stable. 5
9. Relais bistable selon une quelconque des revendications précédentes, les premier et deuxième éléments de contact électrique (CM1, CM2) étant profilés et agencés l'un par rapport à l'autre de sorte que leurs points de contact électriques (CP1, CP2) soient appuyés l'un contre l'autre sous l'effet d'une force de Lorentz agissant sur au moins une partie des premier et deuxième éléments de contact électrique (CM1, CM2) lors de la conduction d'un courant électrique entre les première et deuxième bornes électriques (T1, T2). 10
10. Relais bistable selon la revendication 9, les premier et deuxième éléments de contact électrique (CM1, CM2) comprenant des parties allongées respectives (CE1, CE2) agencées parallèlement, ou de façon substantiellement parallèle, entre elles, de façon à exercer ladite force de Lorentz. 15
11. Relais bistable selon une quelconque des revendications 9 ou 10, le point de contact (CP1) du premier élément de contact électrique (CM1) étant agencé sur une partie d'extrémité de sa partie allongée (CE1), et le point de contact (CP2) du deuxième élément de contact électrique (CM2) étant positionné sur une partie d'extrémité (B) de sa partie allongée (CE2), ladite partie d'extrémité (B) étant pliée ou cintrée autour de la partie d'extrémité de la partie allongée (CE1) du premier élément de contact électrique (CM1), de sorte que le point de contact (CP2) du deuxième élément de contact électrique (CM2) soit forcé contre le point de contact (CP1) du premier élément de contact électrique (CM1) sous l'effet de la force de Lorentz qui agit sur les parties allongées (CE1, CE2) des éléments de contact (CM1, CM2). 20
12. Relais bistable selon une quelconque des revendications précédentes, comprenant un deuxième jeu de deux éléments de contact électrique en contact électrique avec deux bornes électriques correspondantes, et le curseur (SL) étant agencé pour s'engager avec un desdits deux éléments de contact électrique, de façon à couper le contact électrique entre les deux éléments de contact électrique lorsque le curseur (SL) se trouve dans la deuxième position stable. 25
13. Compteur électrique pour mesurer une quantité d'énergie électrique distribuée par une ligne électrique, le compteur comprenant un relais bistable (R) selon une quelconque des revendications 1 à 12. 30
14. Compteur électrique selon la revendication 13, le relais bistable étant agencé pour connecter électriquement la ligne électrique dans son premier état stable et étant agencé pour déconnecter électriquement la ligne électrique dans son deuxième état stable, et le compteur comprenant un module de communication agencé pour recevoir un signal de contrôle d'un émetteur distant, et pour commuter en conséquence le relais bistable de son premier à son deuxième état ou vice-versa, afin de permettre la télécommande de l'accès par un consommateur à une fourniture d'énergie électrique depuis la ligne électrique. 35
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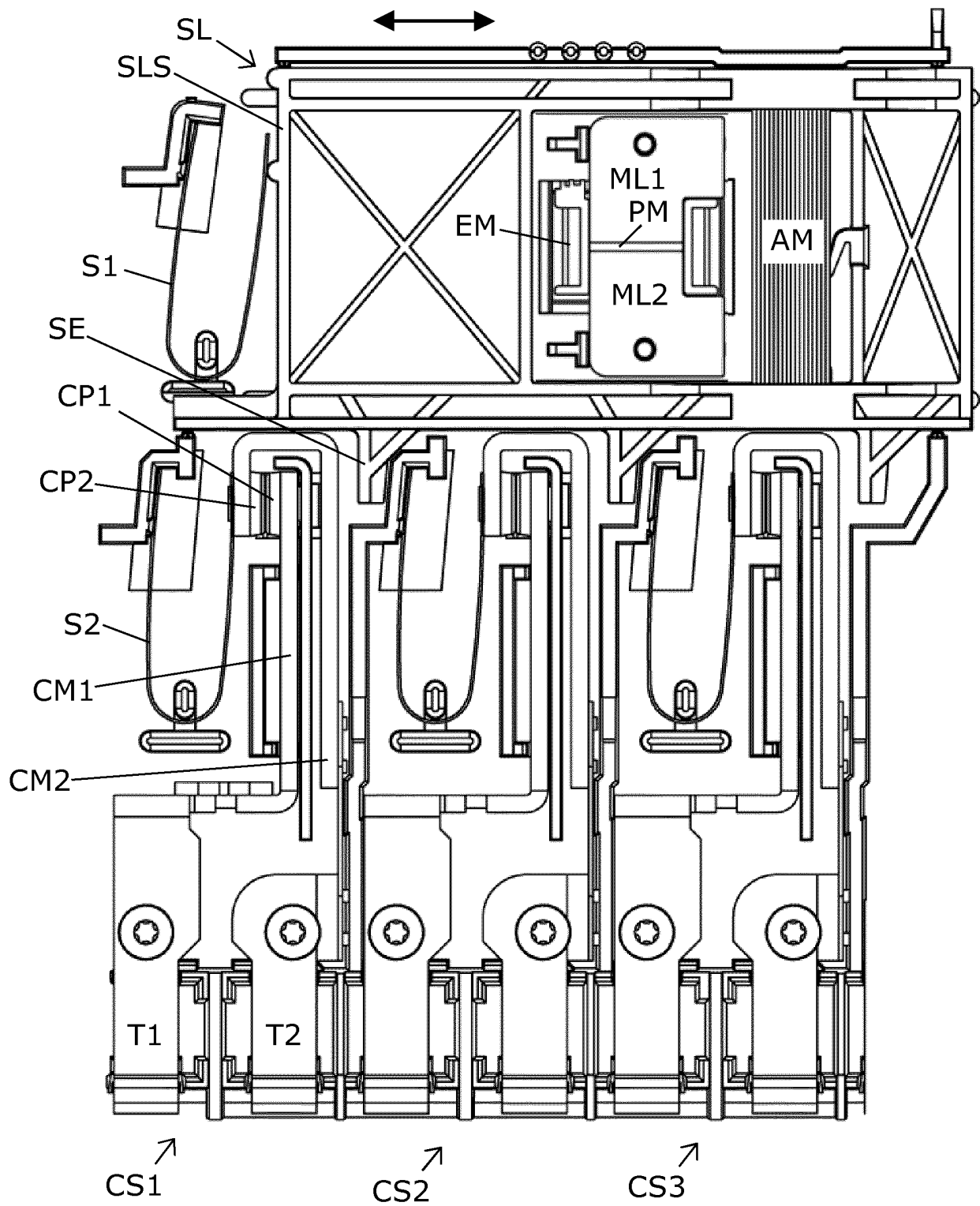


FIG. 1

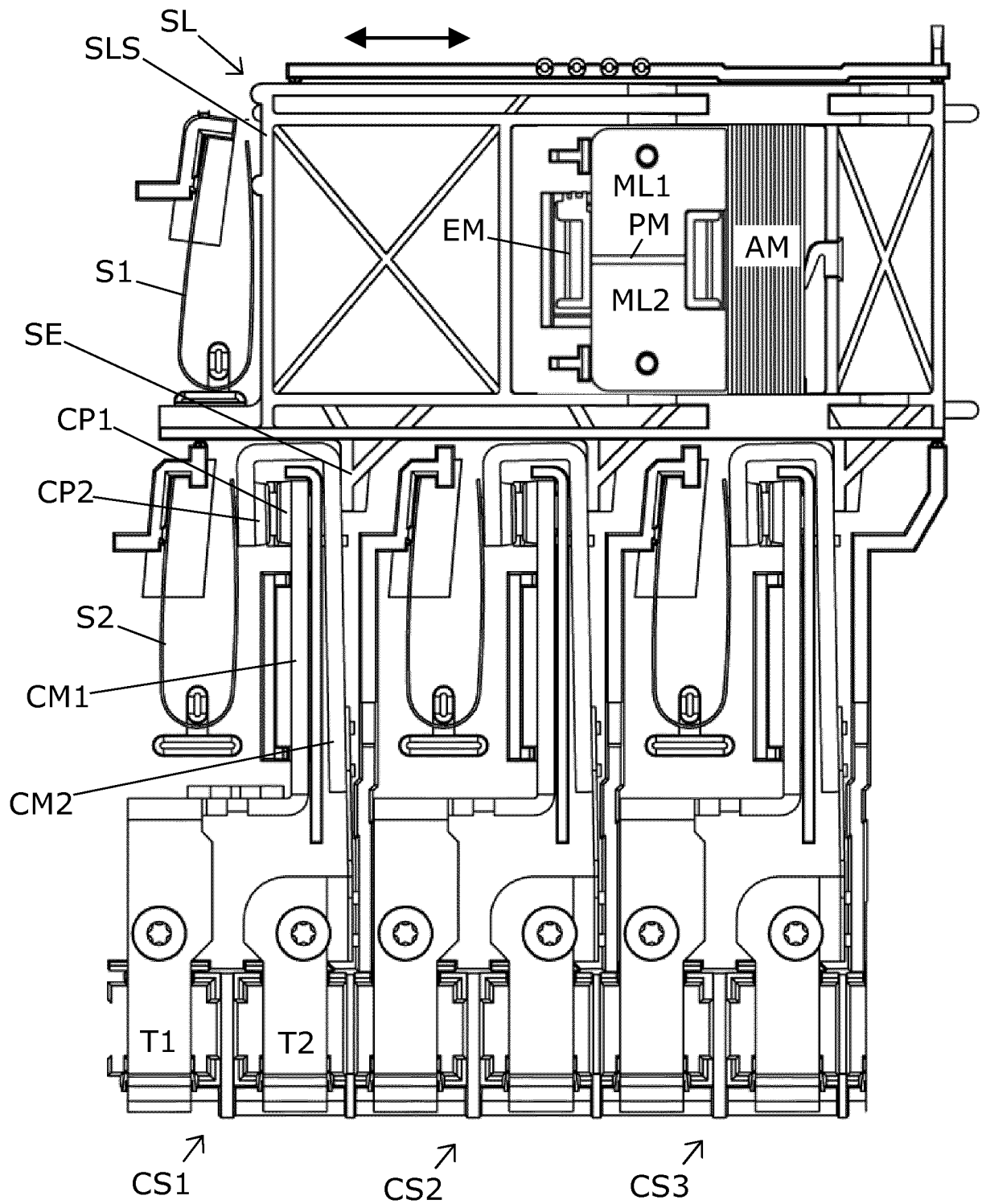


FIG. 2

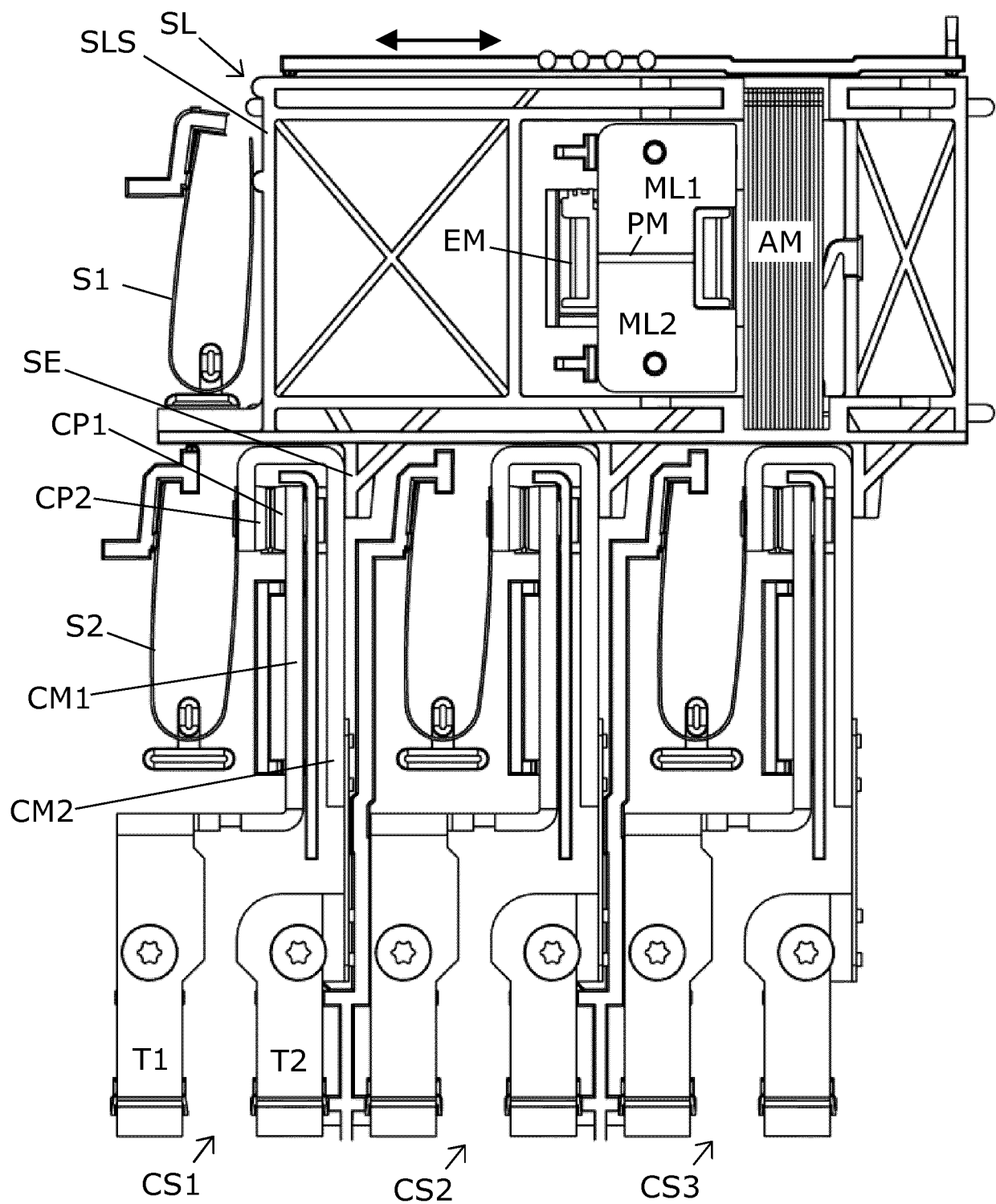


FIG. 3

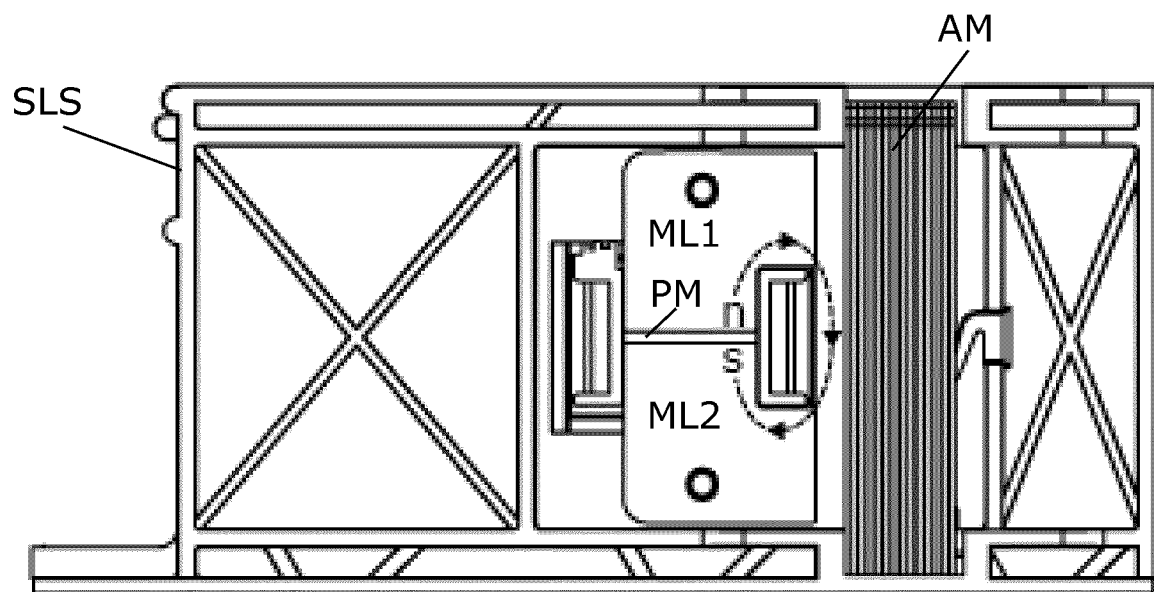


FIG. 4a

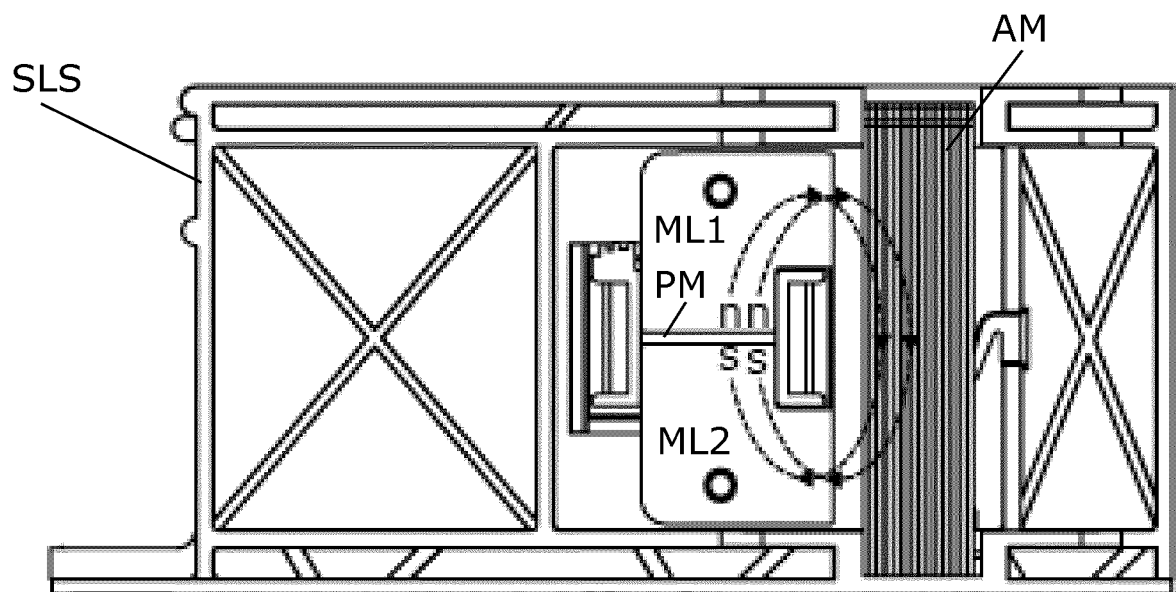


FIG. 4b

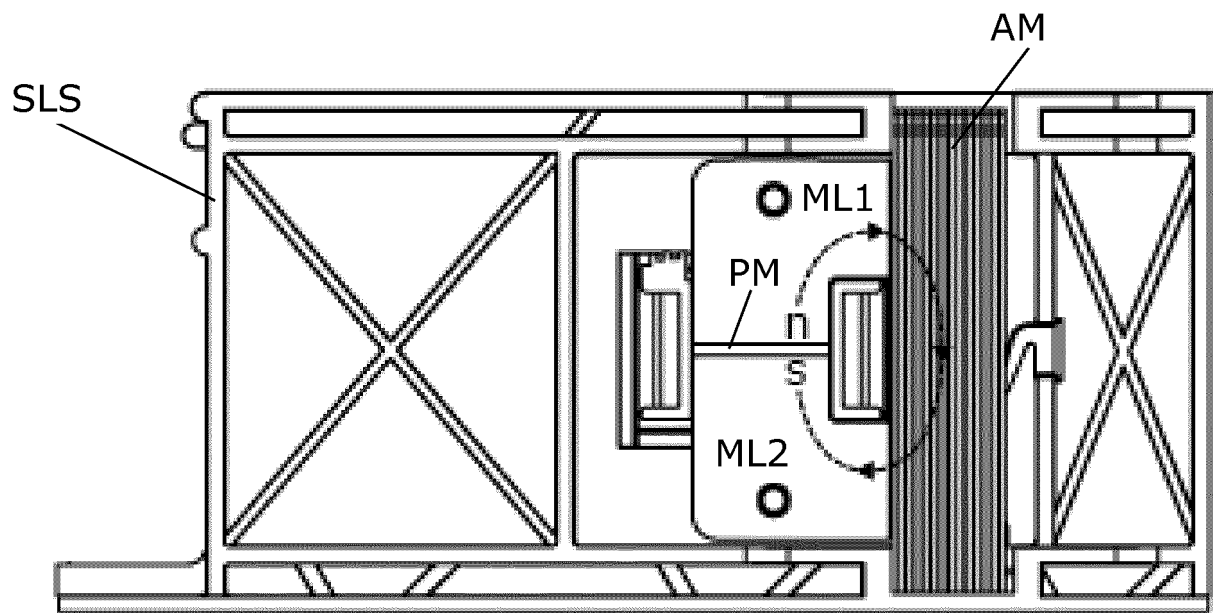


FIG. 4c

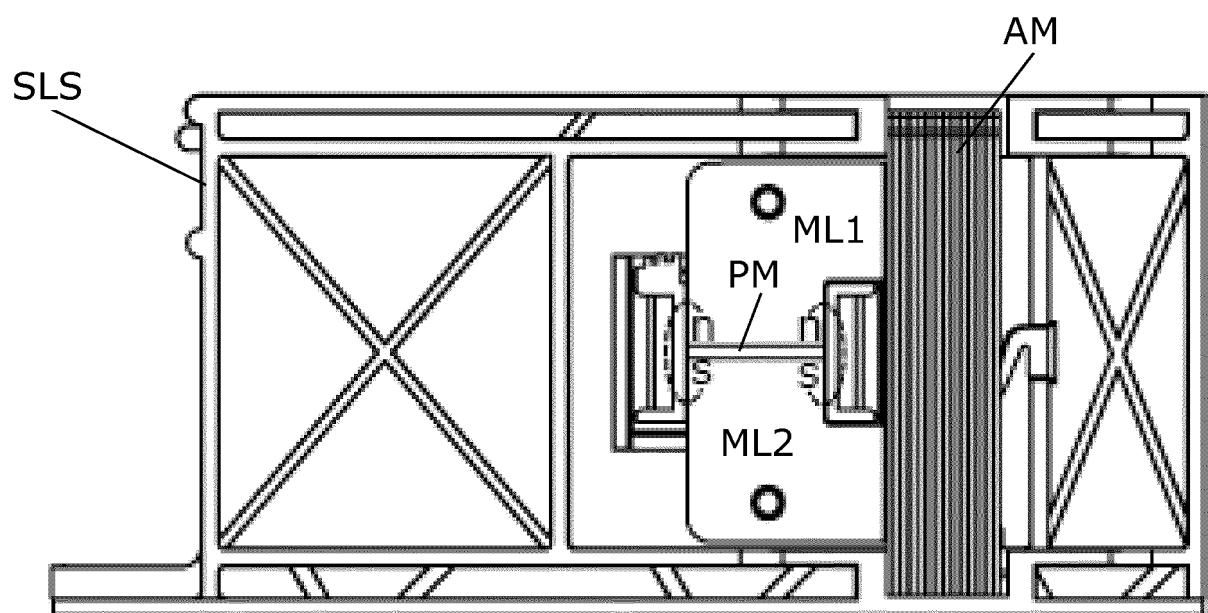


FIG. 4d

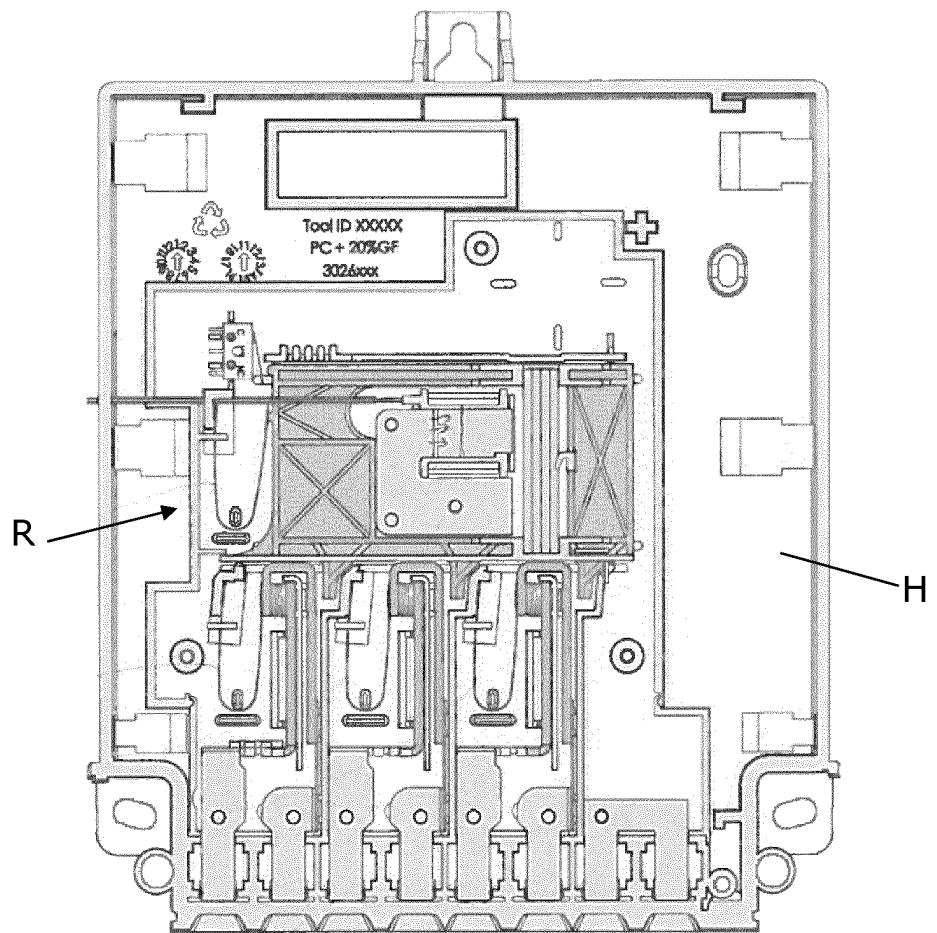
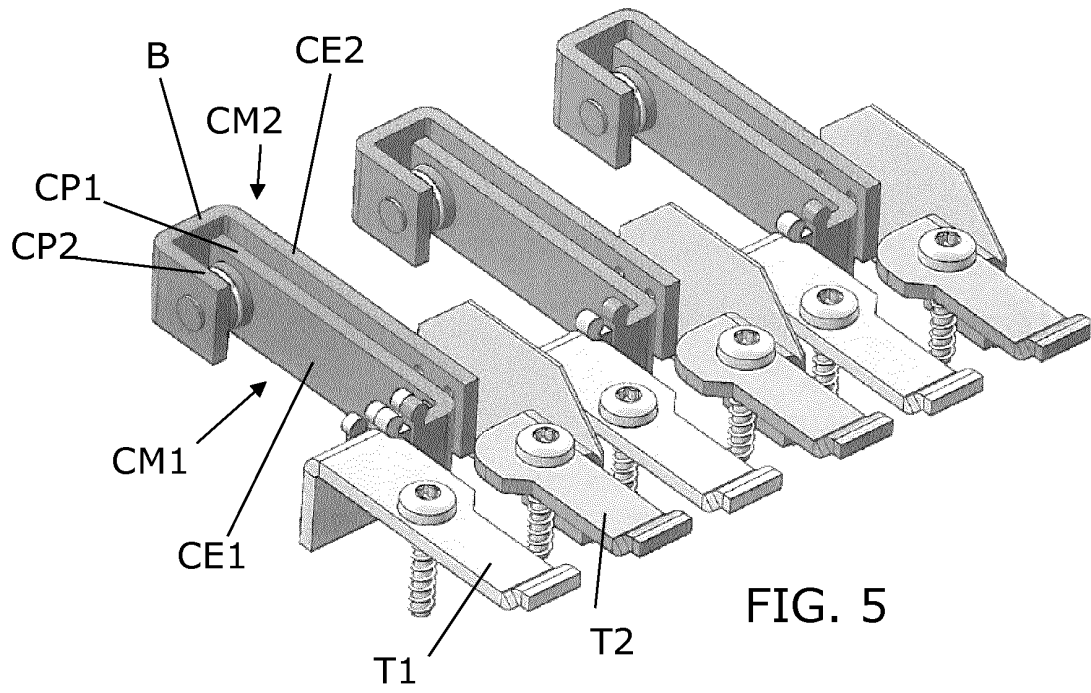


FIG. 6

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 2654063 A1 [0005]
- DE 102012203961 B3 [0005]
- EP 3021341 A1 [0005]
- EP 0534572 A2 [0006]