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Electromagnetic releaseDescription

10 The invention relates to an electromagnetic release for
a protective circuit breaker, in particular for a
residual current circuit breaker according to the
precharacterizing clause of Claim 1.

15 In particular for a mains-voltage-independent residual
current protective device, it is known for the release
used to be a release based on a magnetic circuit on the
compensation principle. For this purpose, a magnetic
yoke in U-shape is provided, around one limb of which a
20 coil is wound; on the yoke there is a permanent magnet,
and the two limbs of the yoke are covered by an
armature, which is spring loaded into the disconnect or
release position. The permanent magnetic acts in such a
way that the armature, in the quiescent state, is
25 attracted against the free ends of the limbs of the
yoke; if a fault current occurs, then the magnetic flux
generated by this acts against the flux generated by
the permanent magnet, so that the spring overcomes the
attraction force and pivots the hinged armature into
the opening position.

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In addition to such holding-magnet releases, blocking-
magnet releases have also been disclosed, but these are
used much less frequently.

35 The coil winding is connected to a secondary winding of
a summation current transformer, whose primary winding
is formed by the live conductor; as soon as a fault
current occurs, current is applied to the coil of the

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release in a manner known per se, and the release responds.

In the event that there is an adhesion layer between the armature bearing face and the surface of the pole, the excess force from the spring, which moves the armature in the disconnect direction, is sometimes inadequate to break the contact between the armature and the pole face, and in this case the release fails.

Since the pole face and the air gap present there are extremely critical variables, it being necessary for the pole surface to be polished in order to achieve an adequate magnetic adhesion force, for example the application of a protective layer as a measure against sticking cannot be used. Furthermore, the geometry of the arrangement makes automated production very much more difficult; the individual parts have to be produced with high precision and monitored and have to be assembled with a great deal of personal, that is to say manual, effort, under clean-room conditions.

Since, however, sticking sometimes cannot be avoided, the user is recommended in general terms to operate a test push-button once a month in order to check the serviceability of the release. When the test push-button is actuated, a fault current is simulated, so that the release responds and the residual current circuit breaker opens.

Since, in particular in the domestic household, regular testing of a residual current circuit breaker is often not performed, consideration has been given to avoiding possible sticking of the hinged armature in the event of a fault current.

To this end, it has been proposed to carry out automatic testing with automatic opening, which can be disadvantageous to the extent that as a result of the



automatic opening of the circuit breaker, current interruptions are produced, which are mostly undesired and present problems, which will not be discussed specifically here.

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In addition, there are also additional devices assigned to the release in the form of additional releases, which are designed, for example, as piezoelectric elements or else as electromagnetic releases.

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However, such additional elements and additional releases increase the outlay on the production of a residual current circuit breaker.

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For this reason, the object of the invention is to provide an electromagnetic release of the type mentioned at the beginning in which sticking is prevented to the greatest possible extent, so that a release of this type can readily be used even in a residual current circuit breaker for unlatching a switching mechanism. In particular, it is intended that the electromagnetic release have fewer parts of simpler design, so that automatic production is improved and time and cost for manufacture can be reduced.

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According to the invention, this object is achieved by the features of Claim 1.

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According to the invention, at least one permanent magnet and at least one pole shoe are assigned to the yoke and to the release plunger in such a way that, in a first position, the plunger is located in the active range of the permanent magnet and of the pole shoe and, in a further position, is located only in the active range of the pole shoe, so that in the first position both the magnetic flux from the coil and that from the permanent magnet, the latter at least partly, run through the plunger and, in the second position, the magnetic field generated by the permanent magnetic runs

shoe and the spring, the pot being closed by means of a cover, through which the plunger reaches, in order to form the release; in this case the cover serves as the first yoke section and the bottom of the pot forms the second yoke section.

This simplifies the manufacture of the release considerably. It is possible to prefabricate the arrangement of the permanent magnet arrangement, pole shoe, coil former and coil and simply insert it into the pot.

Furthermore, in the design according to the invention, there is a further advantage:

If, according to the characterizing features of Claim 14, the end of the plunger is located in the area of the pole shoe when the release, serving as a residual current release, has reached its release position, then the working point of the permanent magnet remains approximately constant in any possible position, since in any possible position a magnetic flux through the permanent magnet, the pole shoe, the plunger and the yoke is ensured.

A further advantageous refinement of the invention according to Claim 16 consists in that, in the so-called released position of the coil, a flux through the permanent magnet can be generated, so that the permanent magnet can be magnetized by means of a pulse originating from the coil. As a result, it is no longer necessary to install the permanent magnet in the pre-magnetized state or to magnetize it from the outside in special, complicated devices, instead the permanent magnet is magnetized only when it has been mounted in the release.

Further advantageous refinements and improvements are to be taken from the further subclaims.

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Using the drawing, in which some exemplary embodiments of the invention are illustrated, the invention and further advantageous refinements and improvements of the invention and further advantages are to be explained and described in more detail. In the drawing:

- Fig. 1 shows a sectional view of an electromagnetic release according to the invention in the first, attracted position,
- Fig. 2 shows the release according to Fig. 1 in a second position,
- Fig. 3 shows a release similar to Fig. 1 in a second position,
- Figs 4 to 6 show sectional views of a further embodiment of the release,
- Figs 7 to 9 show a further release in an illustration corresponding to Figs 4 to 6, and
- Figs 10 and 11 show a schematic illustration to explain the action of the electromagnetic releases according to Figs 1 to 9,
- Fig. 12 shows a sectional view through a mould for manufacturing the coil former,
- Fig. 13 shows a sectional view through the release before insertion into the yoke, and
- Fig. 14 shows a partial sectional view of the release.

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Reference should now be made to the schematic illustration of Figs 1 to 3.

The electromagnetic release according to Fig. 1 has a yoke 10 which has a bowl-like pot 11 which is closed by a cover 12. In the interior of the pot 11, adjoining the inner wall, there is an annular coil 13, which surrounds a plastic sleeve 14, a permanent magnet 15 and a pole shoe 16. The permanent magnet 15 is also annular; it is seated directly on the bottom 17 of the pot 11. The permanent magnet 15 is adjoined by the pole shoe 16 and touches the latter, the pole shoe having two sections 18 and 19 of different internal diameter. The sleeve 14 holds the permanent magnet 15 and the pole shoe 16 in place against the bottom 17. The permanent magnet 15 and the annular pole shoe 16 surround a plunger 20 which, with its one end face, bears against the inner face of the bottom 17 of the pot and, with its other end, projects out of the cover 12 from an opening 21. The plunger 20 has a circumferential annular ridge 22, and between the annular ridge 22 and the pole shoe 16 there is a helical compression spring 23. The internal diameter of the section 19 of the pole shoe 16 is such that an air gap 24 results between the inner face of the section 19 and the outer face of the plunger; in a corresponding way, there is a further air gap 25 between the inner face of the opening and the outer face of the plunger 20. The internal diameter of the permanent magnet 15 then corresponds to the internal diameter of the section 18 of the pole shoe 16.

The permanent magnet 15 then produces a magnetic flux, whose main part 26 which - depending on the alignment of the north and south poles - runs from the permanent magnet 15 into the pole shoe 16 and via the air gap 24 into the plunger 20, from there into the yoke and the bottom 17 of the yoke and back to the permanent magnet.



Between the plunger 20 and the bottom of the yoke there is a very small working air gap 27.

5 In this state, because of the magnetic flux 26 of the permanent magnet 15, the plunger 20 is attracted towards the bottom 17 of the pot 11.

10 If a current then flows through the coil 13, this generates a magnetic flux 28, which runs from the bottom 17 of the pot into the plunger, through the plunger 20 into the cover 12 and back again to the bottom 17 of the pot through the side wall 29 of the bottom of the pot, that is to say, given appropriate polarization, acts counter to the permanent magnet flux 15 26 in the plunger 20. As a result, the flux 26 generated by the permanent magnet 15 is cancelled, and the spring 23 (under compression) moves the plunger in the direction of the arrow P until the ridge 22 comes to bear against the inner face of the cover 12. The end 20 of the plunger 20, which initially bears on the bottom 17 of the pot, has been moved away from the bottom of the pot and is located approximately still in the area of the permanent magnet 15; the working air gap 17 is then sufficiently great that the permanent magnet 15 25 does not move the plunger back again towards the bottom of the pot.

There is also the possibility of dimensioning the plunger 20 or its travel such that the inner end of the 30 plunger ends at the step 30 at which the section 18 merges into the section 19, see Fig. 3.

35 Fig. 5 shows an annular, rectangular yoke 50 having two longitudinal webs 51 and 52 which run parallel to each other and are connected to each other at their one end by means of a transverse web 53, whereas at the other end of the longitudinal web 51 a limb 54 is arranged, and at the other end of the longitudinal web 52 a limb 55 is arranged, the said limbs running towards each



other perpendicular to the longitudinal webs 51, 52 and ending at a specific distance from each other. Inside the longitudinal webs 51 and 52 there is a coil 56, whose coil axis runs parallel to the longitudinal webs 51 and 52. Inside the coil 56, in each case adjacent to the latter and bearing against the inner face of the transverse web 53, are two permanent magnets 57 and 58, which have a rectangular cross section whose width corresponds to the width of the transverse web 53. These permanent magnets 57 and 58 are adjoined by pole shoes 59 and 60 which, in a manner similar to the pole shoe 16, have two sections 61 and 62 and, respectively, 63 and 64, the section 61 and 62 being remote from the yoke 53, as referred to the permanent magnets 57, 58. The thickness of the sections 63, 64, as measured in the direction of the transverse web 53, is lower than the thickness of the sections 61, 62 and corresponds to the thickness of the permanent magnets 57, 58.

Between the permanent magnets 57, 58 and the pole shoes 59, 60 there is a rectangular plunger 65, whose width corresponds to the width of the yoke 50; the rectangular shape of the plunger is such that, between the sections 61 and 62, an air gap is formed in each case which, with regard to its dimensions, corresponds approximately to the air gap 27. The plunger 65 projects beyond the limbs 54 and 55, the ends of the limbs 54 and 55 in each case forming with the plunger 65 an air gap which in a similar way corresponds to the air gap 25. The plunger 65 has extensions 66, 67 projecting in the direction of the transverse web 53, and between the pole shoes 59 and 60 there is located a compression spring 68, which loads the plunger permanently in the direction of the arrow P, that is to say out of the yoke 50.

The action is the same as in Figs 1 to 3: the permanent magnets 57 and 58 generate a magnetic flux (not illustrated) through the pole shoes 59, 60 and the



plunger 65 as far as the transverse web 53; if the coil 56 is energized then - depending on the direction of the current - a flux is produced through the plunger 65, running counter to the flux generated by the permanent magnets 57, 58, so that the attraction force on the plunger generated by the permanent magnets is reduced, as a result of which the force of the compression spring is overcome and the plunger 65 is forced out of the yoke in the direction of the arrow P, until the projections 66 and 67 come to bear against the inner faces of the limbs 54 and 55.

In the design according to Figs 7 to 9, a similar embodiment is provided; instead of a virtually closed yoke, a yoke 80 is provided which has a longitudinal web 81 which, at each of its ends has a limb 82, 83. The longitudinal web 81 is surrounded by a coil 84; the coil 84 is adjoined by a permanent magnet 85 and the permanent magnet 85 is adjoined by a pole shoe 86 which, in terms of its shape, corresponds to the pole shoe 59. Also provided is an armature 87 or plunger 87, corresponding to the armature 65, whose one end is covered by the limb 82 and whose other end projects beyond the limb 83. Provided on the plunger 87 is a projection 88, which is oriented towards the coil 84. Between the pole shoe 86 and the projection 88 there is a compression spring 89, which has the same action as the compression spring 68 or 23. In this case, many types of spring are possible, for example a spiral spring.

The action of the arrangement according to Figs 7 to 9 is the same as that of Figs 4 to 6; the difference is that the yoke is only U-shaped and not closed, as in the design according to Figs 7 to 9.

Figs 10 and 11 show the action in a schematic illustration. A yoke 100 has a first yoke web 101, which is surrounded by a coil 102. The yoke 100, which



here has the form of a figure-of-eight, has a further transverse web 103, in which a permanent magnet 104 is arranged. The central web 105 of the figure-of-eight shape has a working air gap 106. In the arrangement according to Fig. 10, the state illustrated is that in which the magnetic flux 107 originating from the coil 102 cancels the flux 108 originating from the permanent magnet 104 in the area of the working air gap 106, so that the plunger located in the area of the central web 105 can be moved by a suitable spring arrangement. The fundamental basic structure, which Fig. 10 shows, is implemented in a design solution in the configurations according to Figs 1 to 9, the configuration according to Fig. 3 being particularly preferred. On the one hand, the assembly of the electromagnetic release is very simple: the pot is manufactured, the coil is put into the pot and the permanent magnet and the pole shoe as well as the sleeve are put into the coil in this sequence, so that the permanent magnet is located between the bottom of the pot and the pole shoe. The plunger is then inserted, runs through the pole shoe and, in the quiescent state, is attracted towards the bottom of the pot.

As emerges from Figs 3 and 11, in the arrangement according to Fig. 3 the magnetic flux 28 originating from the coil flows through the plunger 20, the pole shoe 19, the permanent magnet 15 into the bottom 17 of the pot and through the side walls of the pot 11 to the cover 12 and from there into the plunger 20. This means that virtually the entire magnetic flux 28 generated by the coil runs completely through the permanent magnet 15, since the distance D , as referred to the length L , is such that the magnetic flux between the plunger 20 and the bottom 17 of the pot is opposed by a high magnetic resistance. Essentially, it can be stated in this case that D should always be greater than L . As a result, the permanent magnet 15 can be magnetized to its working point by the magnetic flux 18 originating



from the coil 13 and, because the magnetic flux which originates from the permanent magnet 15 always runs through it, this also means that the working point of the permanent magnet is changed only insignificantly, that is to say remains essentially stable. On the basis of the arrangement according to Fig. 3, which also applies to Fig. 2, the action of the permanent magnet 15 is also maintained.

Fig. 11 shows the arrangement schematically: the magnetic flux 107 which originates from the coil runs completely or virtually completely through the permanent magnet 104, because of the high magnetic resistance in the working air gap 106A, so that the said permanent magnet can be magnetized by the flux 107 (or 28), and the working point of the permanent magnet 104 also remains stable.

The release illustrated is used in particular as a release in a residual current circuit breaker, the particular advantage being achieved here that sticking of the end face of the plunger 20 to the bottom 17 of the pot can be prevented. The magnitude of the working air gap - by contrast with conventional holding-magnet or blocking-magnet releases, in which the corresponding parts in contact with each other have to be produced extremely precisely and accurately - is not so critical; instead, the free end face of the plunger, which comes to bear against the bottom 17 of the pot, can also be coated with an anti-adhesion layer. This reliably avoids the situation where, in such a magnetic release designed in accordance with the invention, a malfunction of a residual current circuit breaker can occur. The anti-adhesion layer used can be a layer of corrosion resistant material, for example Ni or a nickel alloy.

It should be added that an already premagnetized permanent magnet can also be incorporated, the



configuration according to the invention achieving the situation where the working point of the permanent magnet remains approximately constant in any possible position of the plunger. Furthermore, there is the further advantage that the permanent magnet can be magnetized in the installed state, partial magnetization being carried out in the embodiment according to Fig. 2, and leads to the permanent magnet being magnetized further and further, since as a result its magnetic resistance becomes lower.

Reference should now be made to Fig. 12.

In order to manufacture the internal components of a release, use can be made (as illustrated in Fig. 12 ff) of a pot-like mould 120 which surrounds an internal space 121, the bottom 122 being located at one end, on the right in the drawing. The free end 123 is or can be closed by a cover 124, on whose side facing the internal space 121 a mandrel 125 is integrally moulded, projecting as far as the bottom 122 and ending at a short distance from the latter. The mandrel 125 has two sections 126 and 127, which have different diameters; the diameter of the section 126 adjoining the cover 124 is greater than the remaining section 127; the diameter of the section 126 corresponds to the internal diameter of the annular permanent magnet 15, see Fig. 1 or 2. The transition from the section 126 to the section 127 is stepped and matched to the internal contour of the pole shoe 16, see Fig. 1, so that the section 19 of the pole shoe 16 is matched to the external diameter of the section 127 of the mandrel 125. The step on the mandrel 125 corresponds to the step on the section 19 of the pole shoe 16. Arranged between the pole shoe 16 and the bottom 122 is an intermediate sleeve 128, which bears closely against the bottom 122 and against the pole shoe 16, ensuring that no gaps remain between the cover 124 and the permanent magnet 15 or between the permanent magnet 15 and the pole shoe 16, through which



the compound of the coil former can penetrate inwards. On its outer face, the permanent magnet 15 has a circumferential groove 129. In the area of the bottom 122 and in the area of the cover 124, the inner wall of the internal space 121 widens. In the area of the bottom 122, the internal space 121 has a widening 130, and a return 131 in the area of the cover.

If, after the mould has been assembled, with the introduction of the intermediate sleeve 128 and the fitting of the cover 124 with the mandrel 125, the internal space 121 is potted with a suitable curing material, then the internal space 121 forms the coil former. Material of the coil former 132 engages in the circumferential groove 129 on the permanent magnet and, in this way, ensures that during the demoulding operation the permanent magnet 15 does not fall out but is firmly held within the coil former 132. The pole shoe 16 is then held firmly between the permanent magnet 15 and the coil former.

Fig. 13 shows the coil former 132 with the flange webs 133 and 134, the permanent magnet 15 and the pole shoe 16. The intermediate sleeve 128 has in this case been removed, so that, between the pole shoe and the end on the right of the coil former 132, at which the flange web 130 is located, the accommodation space 22 for the spring 23 remains.

The coil former 132 is wound with the coil 135. A unit is therefore formed from the coil former, permanent magnet 15, pole shoe 16 and coil 135, and can be inserted into the pot-like yoke 11. The spring 23 is inserted into the space between the end of the coil former 132 having the flange 133, and after that the plunger 20 with the ridge 22 is inserted through the spring 23 and the pole shoe 16 and the permanent magnet 15. After the pot 11 has been closed by the cover 12,



99/612

- 15 -

9 May 2000

from which the plunger 20 projects, the release has been completed.

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Patent Claims

1. Electromagnetic release, in particular for a residual current circuit breaker, having a plunger that is loaded by a spring in the release direction, having a permanent magnet arrangement, a coil and a yoke, the coil generating in the yoke a magnetic flux opposed to the permanent magnet arrangement when it is released, so that the spring force overcomes the attraction force of the permanent magnet arrangement, characterized in that the permanent magnet arrangement (15, 57, 85) and the at least one pole shoe (16, 59, 86) conducting the magnetic flux to the plunger (20, 65, 87) are assigned to the yoke (11, 12; 51, 80) and the plunger (20, 65, 87) in such a way that, in a first position, the plunger (20, 65, 87) is located in the active range of the permanent magnet arrangement (15, 57, 85) and of the pole shoe (16, 59, 86) and, in a second position, is located at least partly in the active range of the pole shoe (16, 59, 86), so that in the first position both the magnetic flux of the coil (13, 56, 84) and that of the permanent magnet arrangement (15, 57, 85), the latter at least partly, run through the plunger (20, 65, 87) and, in the second position, the magnetic flux generated by the permanent magnet arrangement (15, 57, 85) runs through the yoke (11, 12; 51, 80), plunger (20, 65, 87) and permanent magnet arrangement (15, 57, 85).
2. Release according to Claim 1, characterized in that the yoke has two yoke sections running parallel to each other, to which the plunger axis runs perpendicularly, and in that the plunger reaches through one of the yoke sections (first yoke section), forming an air gap, whose width remains constant throughout the entire movement of the plunger.

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3. Release according to Claim 2, characterized in that in its first position, the plunger bears against the inner face of the other, second yoke section.

5 4. Release according to Claim 3, characterized in that on its end face facing the second yoke section, the plunger is coated with an anti-adhesion layer.

10 5. Release according to Claim 4, characterized in that the layer consists of a material that is as corrosion resistant as possible, in particular nickel or a nickel alloy.

15 6. Release according to one of the preceding claims, characterized in that the plunger (20, 65, 87) has a ridge (22; 66, 67; 88), and in that the spring (23, 68, 89) is arranged between the one pole shoe (16, 59, 86) and the ridge (22; 66, 67; 88).

20 7. Release according to one of the preceding claims, characterized in that the yoke (50) is a closed ring, in which the coil (56) and, inside the coil (56), the plunger (65), the permanent magnet arrangement (57) and the at least one pole shoe (59) are located, in that
25 the permanent magnet arrangement (57) bears against the inner face of the second yoke section, in that the at least one pole shoe (59, 60) is arranged coaxially with the permanent magnet arrangement (57), in that the permanent magnet arrangement (57) and the pole shoe
30 (59, 60) accommodate the plunger (65) between them in the quiescent state, and in that the plunger (65) reaches through the limbs (54, 55) arranged opposite the first yoke section.



35 8. Release according to one of the preceding claims, characterized in that the yoke (80) has at least a U-shape, in that the coil (84) surrounds one of the webs (81), and in that the limb (82) forming the first yoke section covers the end face of the plunger (87).



9. Release according to Claim 8, characterized in that the U-shaped yoke is assigned a further yoke piece in one piece with it, so that the limbs form two yoke webs running in parallel, the permanent magnet arrangement and the plunger bearing against one yoke web and the plunger reaching through the other yoke web.
10. Release according to one of Claims 1 to 6, characterized in that the yoke (10) has a pot (11), into which the annular coil (13), the permanent magnet arrangement (15) designed as an annular permanent magnet, the annular pole shoe (16), the spring (23) designed as a helical spring and the plunger (20) can be inserted in such a way that the plunger (20) is surrounded both by the permanent magnet (15) and the pole shoe (16) and the spring (23), the pot (11) being closed by means of a cover (12), through which the plunger reaches, to form an electromagnetic drive, so that the cover forms the first yoke section, and the bottom of the pot forms the second yoke section.
11. Release according to Claim 6, characterized in that the pole shoe (16) and the permanent magnet (15) are pressed against the inner bottom of the pot by a sleeve (14) of insulating material.
12. Release according to one of the preceding claims, characterized in that the pole shoe and the permanent magnet are cast into a cylindrical body, which forms a coil former, so that the coil, the coil former, the pole shoe and the permanent magnet form a preassembled unit.
13. Release according to Claim 12, characterized in that the permanent magnet has at least one circumferential ridge or groove, via which it is held on the coil former in a form-fitting manner.



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14. Release according to one of the preceding claims, characterized in that the plunger can be moved away from the first yoke web at most such that its inner end is essentially located in the area of the pole shoe, so that a flux through the pole shoe, the plunger and the yoke is ensured.

15. Release according to Claim 14, characterized in that the distance which the end face of the plunger assumes from the yoke web when driven is greater than the axial length of the permanent magnet arrangement.

16. Release according to Claim 14 or 15, characterized in that in the released position, in which the plunger is essentially located only in the area of the pole shoe, the permanent magnet arrangement can be magnetized by a current pulse through the coil.



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