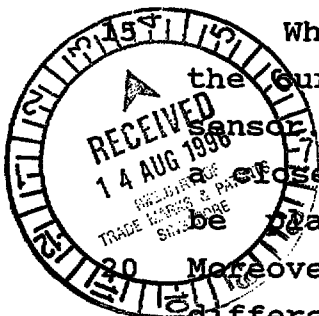


CURRENT SENSOR AND ELECTRICAL APPARATUS INCLUDING IT

This invention relates to an inductive current sensor for electrical apparatus comprising a magnetic circuit of which one part acts as a support for a magnetic field detector element such as a detector coil
5 and a conductor surrounded by the magnetic circuit and traversed by the current to be detected. It also relates to the electrical apparatus provided with such a sensor or sensors.

Current sensors of the type mentioned above are
10 well known and are used in electrical power apparatus such as circuit-breakers, overcurrent relays or speed controllers for the purpose of detecting excess currents so that the supply of the charge connected to the appliance can be cut off.



When the apparatus is assembled, it is helpful if the current conductor can be inserted easily in the sensor. However, in most cases current sensors comprise a closed magnetic circuit in which the conductor must be placed, thereby making assembly non practical.
20 Moreover, the protective apparatus may require different sensors depending on the connectable charges and it is desirable, either during the manufacture of the appliance or during its installation, that it should be adapted or customized depending on its
25 application.

When a current sensor of the type described is constituted by a current transformer, the material of the magnetic circuit presents a strong permeability, typically greater than 5000. In this case a current

transformer is sensitive to interference, and when it is desired to make a magnetic circuit with a separable part, the spurious gap formed at the connection of the separable part to the fixed part has a bad influence on
5 measuring.

When the current sensor is formed by a Rogowski core, permeability is of the order of 1 and the need for a large number of turns for secondary winding means is such that it is not easy to arrange them on a
10 separable part. In addition, coil winding must be carried out continuously on the core in order to ensure immunity to electro-magnetic interference.

The invention aims to reduce the influence of spurious gaps and external interference on a current
15 sensor for electrical apparatus. It also aims to facilitate the assembly of the current sensor in the electrical appliance and the adaptation of said appliance to different charge characteristics.

According to the invention, the magnetic circuit
20 comprises an open magnetic part and a magnetic part separate from the open magnetic part and which carries the detector element, at least one of the two parts of the magnetic circuit being in a material of weak permeability. Said permeability may be comprised
25 between 5 and 100, preferably between 8 and 30. As a result, the gap of the magnetic circuit can be considered as spread along the circuit and the sensor shows little sensitivity to any spurious gap which might be observed at the interface between the separate
30 part and the open part of the magnetic circuit.

The electrical apparatus according to the invention is provided with at least one such current sensor whose open magnetic part is arranged permanently in the casing of the apparatus and whose closing

separate magnetic part is fixed either to a printed circuit board comprising a circuit for processing the electrical signal delivered by the detector element, said processing circuit generating a trip signal when
5 an overcurrent is detected, or to a part or cover detachable from the casing, said part or cover carrying, preferably on the separate magnetic part side, such a printed circuit board.

It should be understood that the permanent open
10 magnetic part can advantageously belong to a lower general purpose part of the apparatus, while the separate closing magnetic part can belong to an electronic processing part specifically designed depending on a rating, particularly a current rating,
15 of the apparatus. In other words, one may assemble to an unchanged bottom part of the electrical apparatus different electronic processing units each adapted to a different electric size. The assembly operation can be executed either by the manufacturer or by the user.

20 The following description of an embodiment read with reference to the accompanying drawings, will provide an explanation of the features and advantages of the invention.

- Figure 1 is a schematic illustration of an
25 inductive current sensor in accordance with the invention.

- Figure 2 is a sectional view of a sensor assembled in an appliance according to the invention.

30 - Figure 3 shows a schematic view of a contactor-circuit-breaker apparatus.

The current sensor 20 is housed in an insulating casing 10 of a low-voltage electrical apparatus, this casing showing a front face 11 which is accessible to an operator from the outside.

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The sensor 20 comprises an open fixed magnetic circuit 21, for example U or L-shaped, fixed by any appropriate means in the casing 10 of the apparatus, and a separate magnetic circuit 22 formed for example
10 by a pallet added so as to bridge the fixed circuit in order to establish a magnetic path without nominal gap for the magnetic flux. When the circuit 21 is L-shaped, an identical L-shaped part may be used for the circuit 22. A power conductor 23 belonging to a low-frequency
15 current path, for example 50 or 60 Hz, of the apparatus is inserted in the aperture 24 of the fixed magnetic circuit 21 into said apparatus and remains fixed in a well-determined position by retaining means. A coil 25 wound around a coil frame 25a associated to the
20 separate magnetic circuit 22 is mounted on a printed circuit board 26, itself fixed to a detachable cover or housing 27 in insulating material and accessible from the outside of the casing, on the front wall 11 side of said casing; the cover 27 can form a part of the front
25 face of the casing (see Figure 2). The magnetic circuit 22 is fixed to the board 26 by legs 28. The circuits 21, 22 have a weak magnetic permeability, preferably lying between 8 and 30, and for this purpose are made of carbonyl iron based material or another analogous
30 material of weak permeability. A resilient element 12 may be placed between the open magnetic circuit 21 and the casing, in combination with a non-represented stop for this circuit 21 so as to help reducing the spurious gap e or e' .

Depending on the case, both circuits 21, 22 are in material of weak permeability or only one of said circuits 21, 22 are in such material. It will be observed that the current measurement is not sensitive to the presence of slight spurious gaps e and e' .

The electrical appliance considered may be a circuit-breaker, a contactor, a protective relay or a speed controller, and may present several sensors, the printed circuit board 26 holding the processing circuit 30 of the signals supplied by the various sensors so as to generate a trip signal. The detachable cover 27 may be a simple plastron (figure 2) or may be arranged as a housing supporting other members.

In Figure 2, the separate part 22 of the magnetic circuit and its detachable carrier cover 27 in the extracted position are represented by dash-lines ; it may be understood that this arrangement facilitates both the installation of the conductor 23 and the changing of the detector element 25. The same cover may of course hold two or three detachable magnetic circuits 22 of corresponding sensors associated to respective phases. A single detachable rail 22 can be provided for a plurality of phases, said rail bearing the respective coils 25. The detector element 25 illustrated in the form of a coil 25 may be constituted by a Hall effect detector or another analogous element detecting the magnetic field generated by the passage of the current in the conductor 23.

Figure 3 shows a polyphase contactor circuit breaker apparatus the casing 10 of which comprises a base body 10a and a front part 10b assembled to the base body ; the front part can itself comprise a functional unit or a plurality of functional units.

The base body 10a has for each phase two power terminals 13,14 to which are associated respective conductive parts 15,16 bearing fixed contacts 17 facing moving contacts 18 located on a contact bridge 19. The
5 contact bridges 19 are borne by a moving support 31. Close to the contacts are situated arc extinction chambers provided with arc extinguishing plates 32.

The conductive part 15 is elevated in a region 15a close to the assembly plane P of the casing parts 10a,
10 10b so as to pass through a fixed U-shaped 21 of the magnetic circuit ; this part 21 lies on surfaces 33 of the base body 10a and projects slightly beyond plane P towards, front part 10b of the casing.

The front part 10b of the apparatus casing has an
15 electromagnet 34 which can actuate directly, as shown by arrow 35, the contact support 31. On the front side of the part 10b is provided a manual control button 36 which cooperates, as shown by arrow 37, with the control unit formed by electromagnet 34 and an
20 electronic processing block 39. The block 39 comprises the closing parts 22 of the magnetic circuits, the detecting coils 25 and the board 26 bearing the overcurrent processing circuit 30. The circuit 30 is electrically connected to the electromagnet coil 34, as
25 shown by arrow 40.

The base body 10a of the apparatus remains the same for a plurality of apparatus types or sizes and it should be understood that differentiation between apparatus is provided by the front part 10b of the
30 casing, due to the interchangeable magnetic circuit closure parts 22, their secondary coils 25 and the specific processing circuits 30.

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CLAIMS

1. Inductive current sensor for electrical apparatus comprising:

- a magnetic circuit of which one part acts as a support to a detector element (25),
- 5 - a power conductor (23) encircled by the magnetic circuit and traversed by the current to be detected,
- the magnetic circuit comprising an open magnetic part (21) and a closing magnetic part (22) separate from the open magnetic part and carrying the detector
- 10 element (25),

characterized in that at least one of the two parts (21, 22) of the magnetic circuit is in material of weak permeability.

2. Sensor according to claim 1, characterized in
- 15 that the permeability of the material of the magnetic circuit lies between 5 and 100, preferably between 8 and 30.

3. Sensor according to claim 2, characterized in that the material of the magnetic circuit is carbonyl
- 20 iron based.

4. Electrical apparatus provided with at least one inductive current sensor comprising:

- a magnetic circuit of which one part acts as a support to a detector element (25),
- 25 - a conductor (23) encircled by the magnetic circuit and traversed by the current to be detected,
- the magnetic circuit comprising an open magnetic part (21) and a closing magnetic part (22) separate from





the open magnetic part and carrying the detector element (25),

characterized in that at least one of the two parts (21, 22) of the magnetic circuit is in a material of weak permeability, the open magnetic part (21) is arranged permanently in the casing (10) of the apparatus and the closing magnetic part (22) is fixed to an interchangeable electronic processing unit (39).

5. Apparatus according to claim 4, characterized in that the interchangeable processing unit (39) carries, on the closing magnetic part (22) side, a printed circuit board (26) comprising a processing circuit (30) of the electrical signal delivered by the detector element (25).

6. Apparatus according to claim 4, characterized in that the open magnetic part (21) of the sensor magnetic circuit is associated to a power conductor (23) located in a base body (10b) of the apparatus, said base body comprising fixed contacts (17) and moving contacts (18) associated to the conductor and arc extinguishing chambers close to the contacts, whereas the closing part (22) of the sensor magnetic circuit is housed with the interchangeable processing unit (39) in a casing front part (10b) fastened to the body part (10b).

7. Apparatus according to claim 6, characterized in that the open magnetic part (21) is located on an elevated region (15a) of a conductive part (15) housed in the base body (10a) close to an assembly plane (P) of the casing parts (10a, 10b).

