

[54] **CURRENT TRANSFORMER**

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[30] **Foreign Application Priority Data**

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[51] **Int. Cl.**..... **H01f 40/06**

[58] **Field of Search** 336/173, 174, 175, 82, 336/96, 195

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[57] **ABSTRACT**

A current transformer switchable at the primary side and operable in an electrical system at high voltage and current for detecting currents in respective current ranges is disclosed. The current transformer includes a secondary system defining a window passage therethrough and having an iron core. A plurality of primary windings surround the core and the windings include respective conductors having respective cross-sections stepped down in magnitude one with respect to the other in correspondence to respective ones of the current ranges. A metallic enclosure surrounds the secondary system in the manner of a hollow ring and constitutes a turn of the primary windings. An elongated conductor member in the form of a compact, short rod extends through the window passage for detecting currents in an additional current range greater than the first-mentioned current ranges.

18 Claims, 8 Drawing Figures

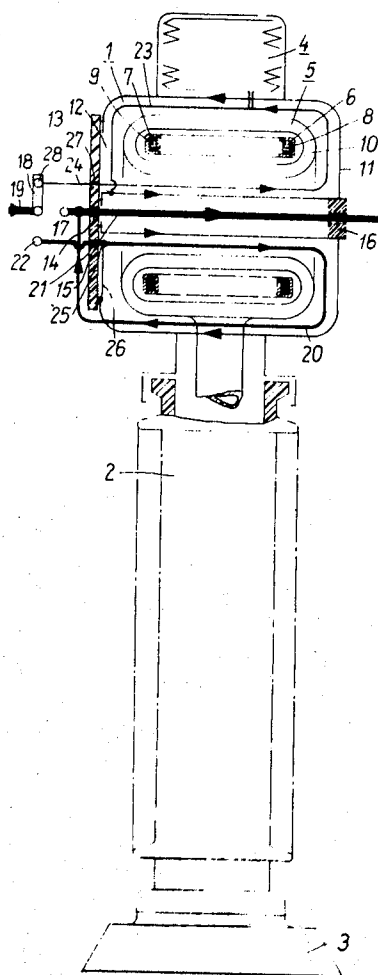


Fig. 1

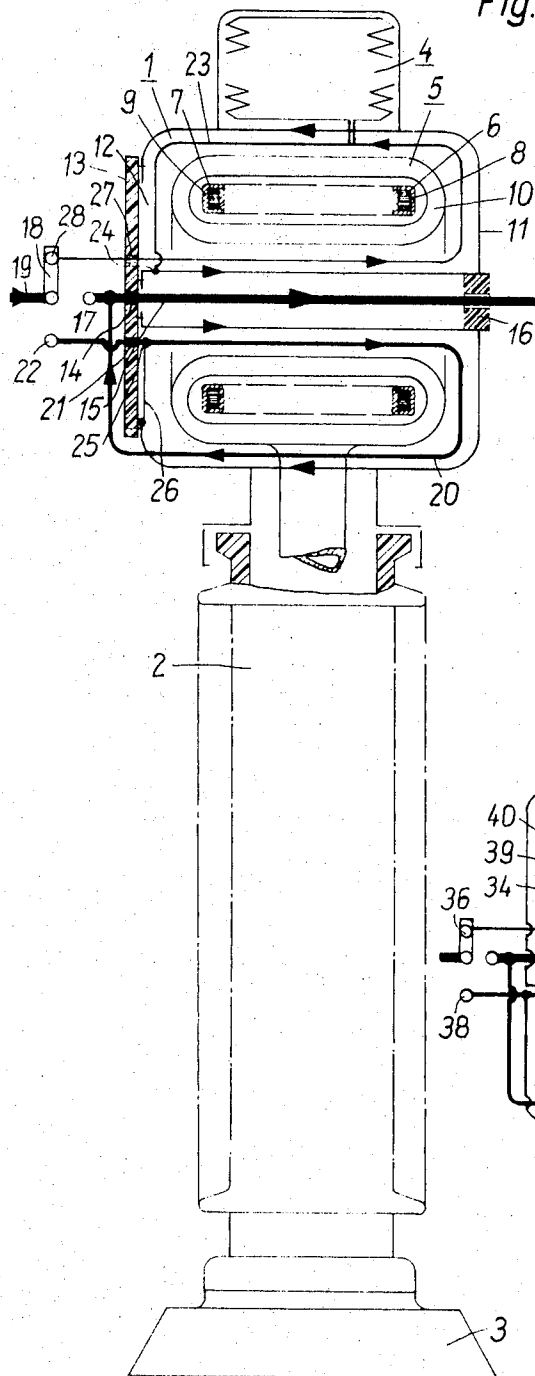
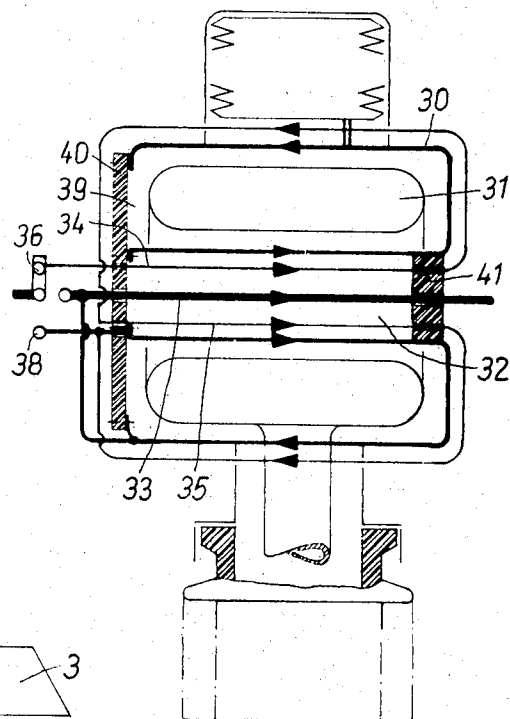


Fig. 2



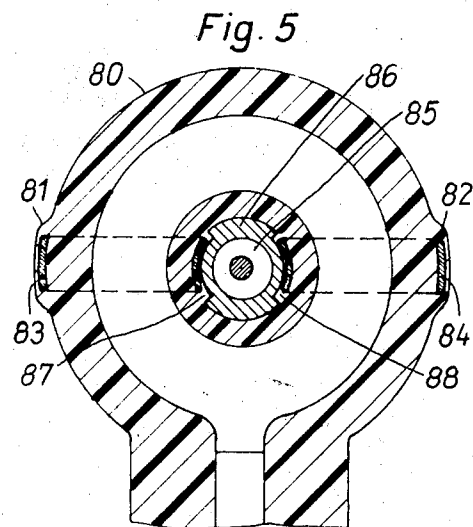
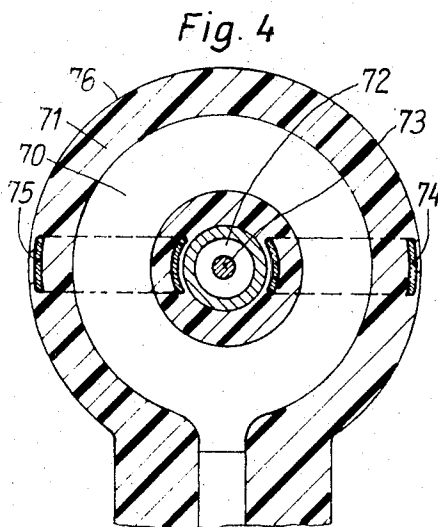
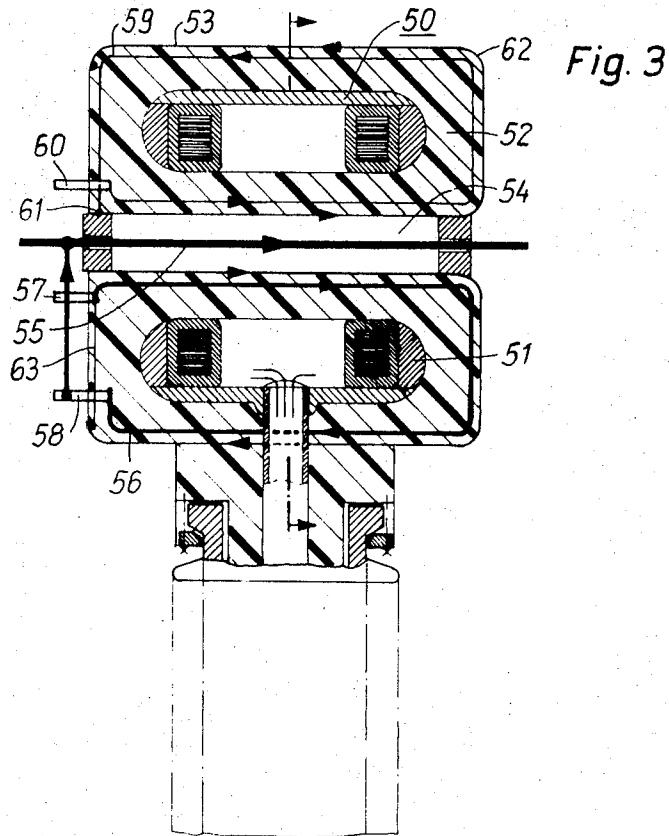


Fig. 6

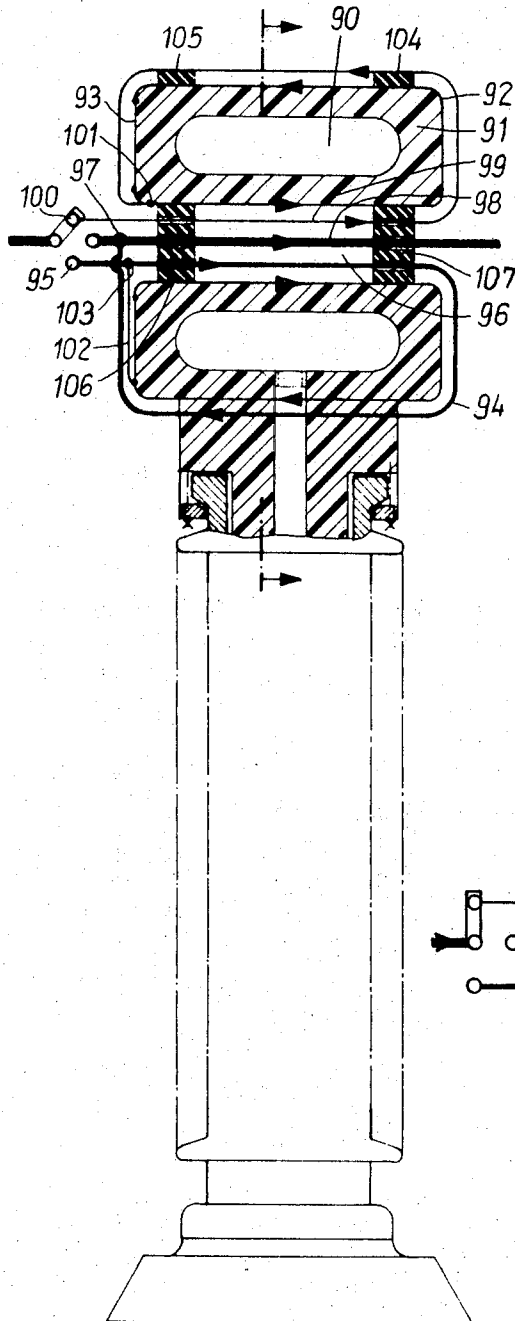


Fig. 7

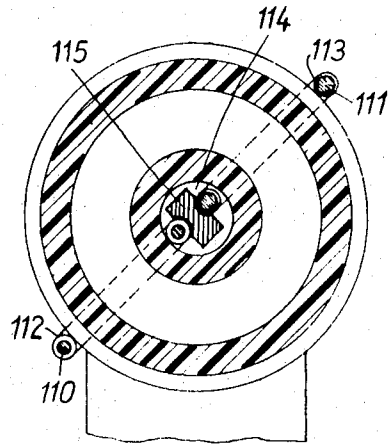
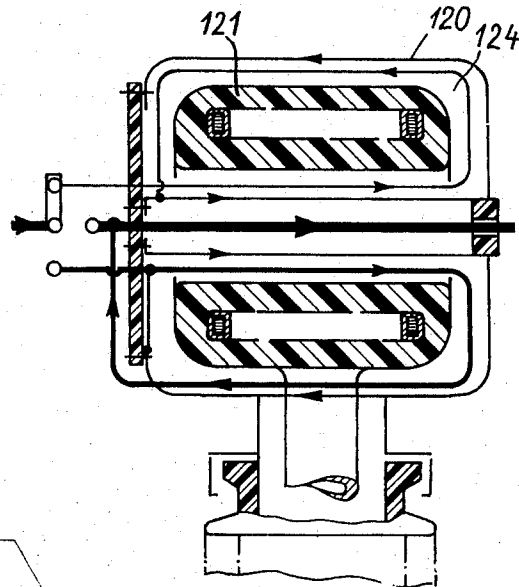


Fig. 8



CURRENT TRANSFORMER

BACKGROUND OF THE INVENTION

The invention relates to a current transformer for high voltage and current. The current transformer is switchable on the primary side and has several windings surrounding the iron core as well as a conductor cross-section decreasing according to the current ranges. For a further current range which is the highest among the current ranges of the windings, an additional, elongated conductor passes through the window of the secondary system in the form of a solid, short rod.

Deutsche Auslegungsschrift 1,231,346 discloses a current transformer wherein the windings consist of one or several conductors which are led around the secondary system. The capability of the known transformer to withstand current surges is therefore limited in the ranges in which the windings are connected by the dynamic strength of the primary windings.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the invention to provide a current transformer switchable on the primary side which not only has a high dynamic strength with respect to the highest current range, for example, as when the rod or the rod and one turn are connected, but also provides a good capability to withstand surge currents if primary windings for measuring currents in lower current-measuring ranges are connected.

The current transformer of the invention is switchable at the primary side and operable in an electrical system at high voltage and current for detecting currents in respective current ranges. According to a feature of the invention, the current transformer includes a secondary system defining a window passage there-through and having an iron core. A plurality of primary windings surround the core and the windings include respective conductors having respective cross-sections stepped down in magnitude one with respect to the other in correspondence to respective ones of the current ranges. A metallic enclosure surrounds the secondary system in the manner of a hollow ring and constitutes a turn of the primary windings. An elongated conductor member in the form of a compact, short rod extends through the window passage for detecting currents in an additional current range greater than the first-mentioned current ranges. According to another feature, the enclosure can be a housing enclosing the secondary system and having a shape corresponding to a hollow ring.

Although it is already known from Deutsche Offenlegungsschrift 1,263,435 to use the head housing as a turn in a high-voltage current transformer of head-type configuration which is switchable on the primary side, the known high-voltage current transformer is suitable only for switching in the ratio of 1 : 2. The reason for this is that the known high-voltage current transformer comprises no additional primary windings besides a short, rod-shaped conductor for measuring the largest currents and the housing as a further turn.

The above-mentioned enclosure has an end face at the window passage. In this end face, the enclosure has a ring-shaped opening in surrounding relation to the window passage. The opening is closed with insulating material. A fluid insulating medium in the form of a gas or a liquid can fill the enclosure. An insulating plate

covers the opening in a fluidtight manner. The plate in turn has openings for passing through and holding the compact rod as well as for accommodating the conductors of the windings.

According to another feature of the invention, the insulating material located inside the metallic enclosure or the metallic housing may also consist of cast resin. In such a case the metallic enclosure may be formed by a conductive coating applied to the cast resin body. As will be explained in more detail below, a metallic housing can be provided if required, this being in addition to the metallic enclosure of a cast resin insulation.

In the current transformer according to the invention, the windings or the turns thereof can be arranged in different ways relative to the housing. It is advantageous in the case of a winding with a single turn to have this turn formed by the housing, because of all windings, except for the rod, the largest current flows through this winding if the current transformer has been switched accordingly.

It may also be advantageous that one winding consists of at least one turn disposed within the metallic enclosure or within the housing, and that an additional winding consists of at least one turn placed within the enclosure or within the housing and a further turn formed by the housing.

In the case of a metallic enclosure filled with cast resin, or of a similarly filled housing, the turns located within the enclosure or the housing can consist of rounded metal strips which are fitted to the curvature of the enclosure or the housing.

It is particularly advantageous to accommodate the turns located within the housing in ribs of the housing. These ribs can then serve at the same time to reinforce the housing.

It is also advantageous if the secondary system encapsulated within the cast resin is appreciably smaller than the housing and if the turns run in the space between the metallic enclosure and the housing, because the turns are then arranged so as to be free of field interference. By means of a further casting about the first casting, the first cast resin body and the turns are then secured in the metallic housing in an insulated manner.

However, it is also possible and may in some cases be also particularly advantageous, to arrange the windings on the outside of the metallic enclosure or on the outside of the metallic housing; this affords the advantage that no feedthrough terminals at all need be brought into the inner space of the housing. If required, this space may be filled with a gaseous or liquid insulating medium. In this case a joint, for example, between a first and a second winding can be eliminated.

The conductors of the windings situated on the outside of the housing or the metallic enclosure can be insulated against each other, against the housing, and can be supported at the housing in different ways. The conductors can, for example, have an insulating coating and/or may be connected with the metallic enclosure or with the metallic housing by means of insulating pieces.

On the other hand, it is also possible to accommodate the conductors of the windings in tubing, which if the conductor is coated with insulation, may consist of metal. In the absence of insulation on the conductors or in addition to such conductor insulation, the con-

ductors can be accommodated in insulating tubing. The tubing need to be only so thick that it can be readily bent. It is preferably made of such size that the tubing together with the solid rod substantially fills the window of the secondary system and is therefore braced; this enables the transformer to withstand high surge currents.

However, it is also possible to provide support bodies of insulating material in the window of the secondary system; these support bodies serve to support the winding conductors in the window, and also serve to achieve a high capability to withstand surge currents if the conductors themselves do not completely fill the core window.

Although the invention is illustrated and described herein as a current transformer, it is nevertheless not intended to be limited to the details shown, since various modifications may be made therein within the scope and the range of the claims. The invention, however, together with additional objects and advantages will be best understood from the following description and in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a current transformer according to the invention. The transformer is here shown as having a head-type configuration.

FIG. 2 illustrates an alternate embodiment of the current transformer of FIG. 1 wherein only the head portion is shown. In this embodiment the windings extend outside of the head housing.

FIG. 3 is a further embodiment of the current transformer of the invention wherein cast resin insulation is provided. The turns of the windings are disposed within the insulation.

FIG. 4 is a section view of the head portion of the current transformer shown in FIG. 3 taken transverse to the longitudinal axis of the head portion.

FIG. 5 is also a section view of the head portion of the current transformer shown in FIG. 3 modified so as to illustrate the disposition of winding turns disposed in ribs of the housing according to a subsidiary embodiment of the invention.

FIG. 6 illustrates still another embodiment of the invention wherein the winding turns extend along the exterior of the housing of the head portion.

FIG. 7 is a section view of the head portion of the current transformer of FIG. 6 and is modified to illustrate how the winding turns can be run in tubing extending about the exterior of the housing according to another subsidiary embodiment of the invention.

FIG. 8 illustrates a current transformer of the invention wherein the turns of the primary winding extend in a space between the housing and the secondary system of the transformer.

DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

In FIG. 1 a current transformer according to the invention will be seen which consists essentially of a head housing 1, an insulating member 2 and a base 3. An expansion body 4 is mounted on the head part 1 for taking up volume changes due to the temperature of the liquid insulating medium present in the current transformer.

In the head housing, the primary turns and the switching arrangement are shown rotated into the

plane of the drawing. The head housing contains a secondary system 5 which consists of several iron cores 6 and 7 with secondary windings 8 and 9. The secondary system 5 is embedded in a body of cast resin or surrounded by an oil-paper insulation 10 which extends into the insulating member 2. The secondary system 5 is accommodated in a metallic head housing 11 having the shape of a hollow ring. The housing 11 has a circular opening 12 at one of its end faces. The opening 12 is closed by an insulation plate 13 so as to be liquid-tight.

The insulation plate 13 has a central cutout 14 through which a short, solid rod 15 is brought out as the primary conductor for the highest current range. The rod 15 is supported in the region of the opposite end face of the housing 11 by a support member 16. On that side, the rod 15 is connected directly with the power system. At its other end, the solid rod 15 is connected to a contact 17 which can be connected by means of a switching strap 18 to the conductor 19 which represents the other connection of the current transformer to the system.

In addition to the solid rod 15 as the primary conductor, a winding 20 is disposed in the head housing 11 of the current transformer; this winding consists of only a single turn and is brought with its one end from the outside into the housing 11 through a cutout 21 in the insulation plate 13; this turn is connected at its other end directly with the solid rod 15. The end of the primary winding 20 which is not connected with the rod 15 is brought externally to a switching contact 22, which can likewise be connected with the conductor 19 by means of the switching strap 18.

In addition to the winding 20, the current transformer also comprises a further primary winding 23 which consists of a turn extending inside of the housing 11, and of an additional turn which is formed by the head housing 11. At the point 24, the first turn is metallically connected to the housing 11. Between the housing 11 and a point 25 on the turn of the first primary winding 20, a conductor 26 is provided for making a metallic connection. The start of the further primary winding 23 is brought out through a cutout 27 in the insulator plate 13 to a contact 28. In the position of the switching strap 18 shown, the contact 28 is connected to the conductor 19.

It will be seen from FIG. 1 that for the position of the switching strap 18 shown, the simple nominal current can flow; the lowest current range is therefore connected. The current transformer then comprises a series circuit consisting of the additional primary winding 23 and the primary winding 20 and the solid rod 15, and is therefore excited on the primary side by four turns. If the switching strap 18 is switched to the contact 22, the winding 20 is connected in series with the rod 15 and is therefore switched to the next higher current range. Twice the nominal current can then be measured. If, however, the switching strap 18 is connected to the contact 17, only the solid rod 15 is effective and the highest current range is thereby switched in and four times the nominal current can be measured.

In the head housing according to FIG. 2, only the secondary system 31 with its corresponding insulation is accommodated inside the housing 30. Within the window of the secondary system 31 or expressed otherwise, in the hollow ring-shaped housing 30, the solid

rod 33 extends longitudinally for the highest current range, as well as a first turn 34 and a further turn 35 of a primary winding which comprises a total of two turns. The one end of this primary winding is connected to a contact 36 of a switching arrangement, while the other end of the primary winding with the turns 34 and 35 is connected with the metallic housing 30. The metallic housing 30 constitutes one turn of a further primary winding, which consists of only this one turn. The housing 30 is therefore connected on the one hand with a contact 38 of the switching arrangement and, on the other hand, directly to the solid rod 33.

The housing 30 again has a circular opening 39, which is closed off by means of an insulation plate 40 in a liquid-tight manner. In the insulation plate 40, cut-outs for bringing out the winding conductors as well as the solid rod are provided. The plate 40 therefore serves as a support element for the primary conductor and contributes to increase the dynamic strength. On the opposite side of the head housing 30 is provided a support member 41, which is arranged within the window 32 and serves for supporting the primary conductors.

In the embodiment of FIG. 3 the secondary system 50 is supported by a grounded core mounting 51 and is embedded in a cast resin body 52. The cast resin body 52 is surrounded by a metallic housing 53 which is open at one end face. This opening can be used to place the casting resin in the housing 53.

In the embodiment shown in FIG. 3 only the solid rod 55 is disposed in the window 54; the other turns are embedded in the cast resin body 52. Thus, a primary winding consisting of one turn 56 is arranged inside the cast resin body 52 and brought with its one end to an external terminal 57 which represents a contact of a switching arrangement (not shown). The other end of the turn 56 is brought to another external terminal 58 which is connected with the solid rod 55.

A further primary winding consists of a turn 59 embedded in the cast resin body 52. The turn 59 is connected to an external terminal 60 which serves as a contact of the switching arrangement. The other end of the turn 59 is connected with a metallic housing 62 at a point 61. The housing 62 therefore forms another turn of the further primary winding. The housing 62 is connected via a connecting line 63 to the end of the turn 56 which in turn is connected to the external terminal 57. In this embodiment no insulation plate is therefore necessary and, accordingly, there is also no seal for this plate.

In the embodiment of FIG. 4 a secondary system 70 is shown embedded in a cast resin body 71. A solid rod 73 is again situated in the window 72. Turns 74 and 75, which are comparable to the turns 56 and 59 according to FIG. 3, consist in the embodiment of FIG. 4 of rounded metal strips, which are fitted to the curvature of the housing 76 and can therefore be disposed in the immediate vicinity of the wall of the housing.

FIG. 5 shows that the housing 80 is provided with ribs 81 and 82 in which the rounded metal strips of turns 83 and 84 are held. The ribs 81 and 82 advantageously reinforce the mechanical strength of the head housing 80. The area surrounding the window 85 of the housing 86 is also provided with cutouts 87 and 88 for accommodating the winding conductors.

In the embodiment of FIG. 6 the secondary system 90 is again embedded in a cast resin body 91. The cast

resin body 91 is surrounded on the outside by a housing 92 which again has a circular opening 93 at its end face. In this embodiment, no turns of the primary winding are led within the cast resin body 91; instead, the turns run outside of the cast resin body 91 and outside of the housing 92. Thus, a primary winding with its only turn 94 is first led from a contact 95 through the window 96 and outside around the housing 92 to a joint 97 with the solid short rod 98. Likewise, within the window 96 is disposed the conductor of a turn 99 of another primary winding; this conductor extends from a contact 100 and is metallically connected to head housing 92 at the point 101 after one turn. The head housing 92 forms a further turn of this primary winding by being connected, via a connecting conductor 102, with the end of the turn 94 that is connected to the contact 95; this junction is made at the point 103.

Referring still to FIG. 6, the conductors of the primary winding are provided with an insulating coating and are arranged so as to be insulated by the insulator pieces 104 and 105 relative to the housing 92. Insulators 106 and 107 are provided for securing the conductors within the window 96.

The insulators 104 to 107 become unnecessary if, as is shown in FIG. 7, the conductor 110 of the one primary winding and the conductor 111 of the other primary winding are run in tubing 112 and 113; the conductors 110 and 111 can be compared with the conductors of the turns 94 and 99 of the embodiment according to FIG. 6. The tubes 112 and 113 are of relatively great stiffness, and their diameter can be chosen so that, together with the solid rod 115, they fill the window 114 to a great extent; the primary conductors are thereby braced in the window with respect to each other and this achieves a high capability to withstand current surges.

The invention provides a switchable current transformer which is distinguished by its capability to withstand current surges. The current transformer can be used in this connection not only for switching in the ratio 1 : 2 : 4 but also for any other switching ratios if its primary windings are configured accordingly.

FIG. 8 illustrates still another embodiment of the invention wherein a metal housing 120 encloses a body of casting resin 121 containing the secondary system. The secondary system enclosed by the casting resin is substantially smaller than the housing 120 so that the housing 120 and the body of casting resin 121 conjointly define a space 124 wherein the turns are run. These turns are then not subjected to field disturbances. An additional casting within the housing 120 can be provided to insure that the turns and the cast resin body 121 are insulated in fixed position inside housing 120.

What is claimed is:

1. A current transformer switchable at the primary side and operable in an electrical system at high voltage and current for detecting currents in respective current ranges comprising a secondary system defining a window passage therethrough and having an iron core; a plurality of primary windings surrounding said core, said windings including respective conductors having respective cross-sections stepped down in magnitude one with respect to the other in correspondence to respective ones of the current ranges; a metallic enclosure surrounding said secondary system in the manner of a hollow ring and constituting a turn of said primary

windings, said enclosure having a wall portion extending through said window passage so as to cause said enclosure to be electromagnetically linked with said secondary system, and an elongated conductor member in the form of a compact, short rod extending through said window passage for detecting currents in an additional current range greater than the first-mentioned current ranges.

2. The current transformer of claim 1, said enclosure being a housing enclosing said secondary system and having a shape corresponding to a hollow ring.

3. The current transformer of claim 1, said enclosure having an end face at said window passage; said enclosure having a ring-shaped opening in said end face in surrounding relation to said window passage.

4. The current transformer of claim 3, comprising a fluid insulating medium filling said enclosure; and an insulating plate for covering said opening fluid-tight, said plate in turn having openings for passing through and holding said compact rod as well as for accommodating said conductors of said windings.

5. The current transformer of claim 3, comprising an insulating body of cast resin disposed inside said enclosure, said secondary system being imbedded in said body of cast resin.

6. The current transformer of claim 5, said metal enclosure being a conductive coating applied to said body of casting resin.

7. A current transformer switchable at the primary side and operable in an electrical system at high voltage and current for detecting currents in respective current ranges comprising a secondary system defining a window passage therethrough and having an iron core; a plurality of primary windings surrounding said core, said windings including respective conductors having respective cross-sections stepped down in magnitude one with respect to the other in correspondence to respective ones of the current ranges; a metallic enclosure surrounding said secondary system in the manner of a hollow ring and constituting a turn of said primary windings; an elongated conductor member in the form of a compact, short rod extending through said window passage for detecting currents in an additional current range greater than the first-mentioned current ranges; said enclosure having an end face at said window passage, said enclosure having a ring-shaped opening in said end face in surrounding relation to said window passage; and, an insulating body of cast resin disposed inside said enclosure, said secondary system being imbedded in said body of cast resin, said primary windings having respective turns disposed in said body of cast resin, said turns being respective rounded metal strips, each of said metal strips having a curvature corresponding to the curvature of said enclosure.

8. The current transformer of claim 7, said enclosure having ribs, said turns being accommodated in said ribs.

9. A current transformer switchable at the primary side and operable in an electrical system at high voltage and current for detecting currents in respective current ranges comprising a secondary system defining a window passage therethrough and having an iron core; a plurality of primary windings surrounding said core, said windings including respective conductors having respective cross-sections stepped down in magnitude one with respect to the other in correspondence to respective ones of the current ranges; a metallic enclosure

sure surrounding said secondary system in the manner of a hollow ring and constituting a turn of said primary windings; an elongated conductor member in the form of a compact, short rod extending through said window passage for detecting currents in an additional current range greater than the first-mentioned current ranges; said enclosure having an end face at said window passage, said enclosure having a ring-shaped opening in said end face in surrounding relation to said window passage; an insulating body of cast resin disposed inside said enclosure, said secondary system being imbedded in said body of cast resin; and, a housing surrounding said enclosure and said cast resin body containing said secondary system, said enclosure and said housing defining a space therebetween, said primary windings having respective turns disposed in said space.

10. A current transformer switchable at the primary side and operable in an electrical system at high voltage and current for detecting currents in respective current ranges comprising a secondary system defining a window passage therethrough and having an iron core; a plurality of primary windings surrounding said core, said windings including respective conductors having respective cross-sections stepped down in magnitude one with respect to the other in correspondence to respective ones of the current ranges; a metallic enclosure surrounding said secondary system in the manner of a hollow ring and constituting a turn of said primary windings; an elongated conductor member in the form of a compact, short rod extending through said window passage for detecting currents in an additional current range greater than the first-mentioned current ranges; said enclosure having an end face at said window passage, said enclosure having a ring-shaped opening in said end face in surrounding relation to said window passage; and, an insulating body of cast resin disposed inside said enclosure, said secondary system being imbedded in said body of cast resin, said primary windings having respective turns mounted on the exterior of said enclosure.

11. The current transformer of claim 10 comprising insulating pieces for mounting the conductors of said turns on said exterior of said enclosure.

12. The current transformer of claim 10, comprising tubes extending along the exterior of said enclosure, the conductors of said turns being run in said tubes.

13. The current transformer of claim 12, said tubes being made of metal.

14. The current transformer of claim 12, said tubes being made of insulating material.

15. The current transformer of claim 12, a portion of each of said tubes extending through said window passage, said portions of said tubes and said elongated conductor member substantially filling said window passage.

16. The current transformer of claim 10, portions of the conductors of said turns extending through said window passage, the current transformer comprising support bodies of insulating material disposed in said window passage for supporting said portions of said conductors and said elongated conductor member therein.

17. The current transformer of claim 1, one of said windings of said plurality of windings consisting of a single turn, said single turn being formed by said metallic enclosure.

18. The current transformer of claim 1, said plurality of windings being at least two in number, one of said two windings consisting of at least one turn being run within said metallic enclosure, and said other one of said two windings consisting of at least one turn dis-

posed within said metal enclosure and one further turn, said further turn being formed by said metallic enclosure.

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