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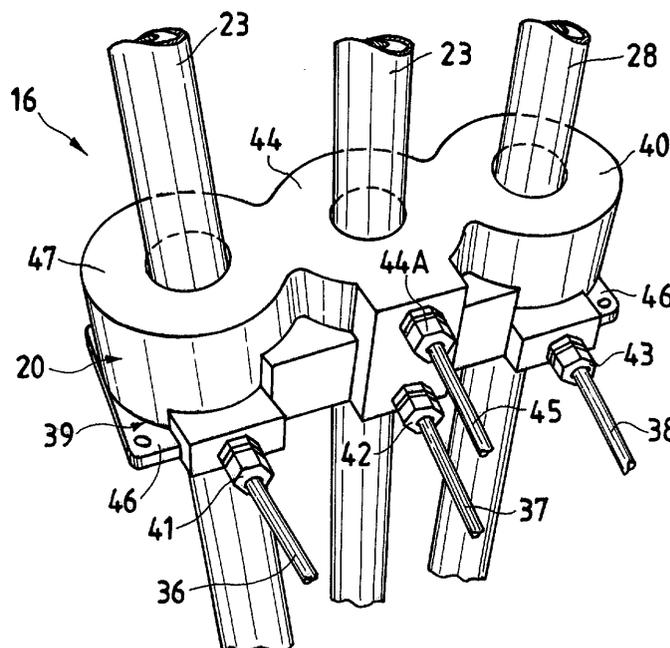
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(54) Compact measurement apparatus for the protection of medium-voltage line

(57) A compact apparatus (16) for detecting current, which travels in medium-voltage insulated cables (23), comprising a single epoxy resin block (20) comprising a series of toroidal windings (40, 44, 47) combined with a further winding (39) for collection of the phases; the apparatus (16) takes samples of current from the medium-voltage cables (23) connected to a bar switch and

disconnecting switch (22), guaranteeing maximum reliability in the picking up and sending of signals to protection relays (26) for short-circuits, overloads and unbalancing between the phases, as well as the reading and detection of the phase and grounding currents, in order to measure all of the functionalities and malfunctions of the electrical line.

Fig.2



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Description

[0001] The present invention refers to a compact apparatus for picking up current in a medium-voltage line suitable for being connected to a protection relay, which drives a medium-voltage automatic switch.

[0002] Medium-voltage switches for indoors are currently known which use air or gas (usually sulphur hexafluoride, SF₆) to extinguish the electric arc and as insulating means between fixed and mobile main contacts.

[0003] Medium-voltage automatic tri-polar switches, with a nominal voltage of up to 24 kV, are used in all applications of the secondary distribution of medium voltage and in medium-voltage/low-voltage transformation substations in buildings, offices in the industrial sector in general and in tertiary industry.

[0004] In particular, sulphur hexafluoride (SF₆) switches are particularly suitable for service in primary and secondary distribution stations, where there is the need to carry out fast shut down cycles in overhead and cable distribution lines, for manoeuvring industrial power factor correction units with heavy-duty operation and limited maintenance, for the command of motors and, in general, for high reliability and long lifetime applications.

[0005] The interruption of the arc is normally realised through self-pneumatic blow out of SF₆ gas combined with the contribution of self-generation and, therefore, with limited absorption of mechanical energy.

[0006] The system operates normally sealed under pressure and is suitable for repeated fast shut downs, operating with limited overvoltages also in the manoeuvre of small inductive and capacity voltages.

[0007] The poles, placed in cylinders of casting resins with gas sealing systems, and the support and command structures of the tri-polar switch can realise fixed or removable front and/or side operations.

[0008] Moreover, the aforementioned automatic switches are equipped with current sensors and/or circuit-breakers or electronic maximum current relays, powered by themselves, which allow use in unmanned mediumvoltage/low-voltage transformation substations without auxiliary power supply.

[0009] Currently, electronic relays for protecting the maximum current power themselves with current reducers (transformer, 1, 2, 3, 4), which are applied on board the switch, so as to guarantee the maximum homopolar and directional safety protection and protection from overcurrents in relation to all types of data which can be detected inherent to the protection problems.

[0010] The two or three transformers applied to the switch supply the energy necessary for the operation of the relay and for the switching off of the switch through a demagnetisation actuator group applied to the command, which allows overloads (at long reverse time and at adjustable fixed time) and short-circuits (at adjustable independent time) to be detected.

[0011] Alternatively, the maximum power circuit-breakers can be realised with a microprocessor and are suitable for taking care of the function of protection against overload and against instantaneous and delayed short-circuit, as well as the function of protection against grounding failure.

[0012] In general, however, the different forms of protection devices for automatic tri-polar switches have some drawbacks.

[0013] First of all, in the case in which electronic protection relays are used, it is necessary to wind a series of toroids on board the switch, with the inevitable consequences due to problems of electromagnetic interference, which translate into the need to foresee a specific insulation between each toroid and the respective pole, adding to the encumbrance, connection time, connection procedures and causing the substantial lack of practicality and reliability of the entire structure. Then, in the case of use of microprocessor circuit-breakers, in which the problem of electromagnetic interference is partially solved, one of the drawbacks encountered most is that of the substantial production, installation and operating costs.

[0014] The purpose of the present invention is therefore that of avoiding the aforementioned drawbacks and, in particular, that of realising a compact measurement apparatus for the protection of medium-voltage lines with medium-voltage automatic switches, which allows extreme reliability in general to be obtained, capable of being used without substantial interventions or complex treatments on board the switchboard, at the same time keeping the possibility of effectively measuring the data relative to the problems of protection of the electrical lines.

[0015] Another purpose of the present invention is that of realising a compact measurement apparatus for the protection of medium-voltage lines, which allows the carrying out of a measurement of the functions or malfunctions of the current circulating in the medium-voltage lines, of a reading and detection of the grounding currents, of a pinpointing of short-circuits and of possible unbalances between the phases, without using particularly expensive components and without foreseeing particular or extremely specific insulation devices.

[0016] A further purpose of the present invention is that of indicating a compact measurement apparatus for the protection of medium-voltage lines which is highly precise, stable, effective and safe.

[0017] The last but not least purpose of the invention is that of realising a compact measurement apparatus for the protection of medium-voltage lines at a low cost and without using complex or expensive technologies.

[0018] Such purposes are achieved by a compact measurement apparatus for the protection of medium-voltage lines, according to claim 1, to which we refer for the sake of brevity.

[0019] Advantageously, the protection apparatus according to the invention includes within a single epoxy

resin block, once enclosed in a container made from thermoplastic material, a combined series of toroidal windings, having a sufficiently long core to obtain good electrical performance, and a further winding, suitable for collecting the phase current, separated from the other windings by the resin insulation.

[0020] The apparatus allows a series of samples of electric current to be taken, in order to obtain both homopolar and directional protection, thus allowing the function of protection against overload, against instantaneous and delayed short-circuit and against grounding failure to be taken care of.

[0021] The detection of the line and grounding currents, both in nominal conditions and in the presence of disturbances, can be carried out by means of a protection relay, combined with the apparatus object of the present invention which, thanks to suitable procedures controlled by an internal microprocessor, allows adequate active current protection, defined by the prevailing national and international electrotechnical regulations, to be realised.

[0022] Further purposes and advantages of the present invention shall become clearer from the following description and from the attached drawings, provided as an example and not for limiting purposes, in which:

- figure 1 is a schematic front view of a measurement apparatus for the protection of medium-voltage lines, connected to a medium-voltage automatic tri-polar switch and realised according to traditional techniques;
- figure 2 is a first perspective view of a compact measurement apparatus for the protection of medium-voltage lines, realised according to the present invention;
- figure 3 is a second perspective view of a compact measurement apparatus for the protection of medium-voltage lines, realised according to the present invention;
- figure 4 represents a schematic perspective view of an example of application of the compact measurement apparatus for the protection of medium-voltage lines, according to the invention.

[0023] With particular reference to the quoted figure 1, a conventional embodiment of a medium-voltage automatic tri-polar switch is generically indicated with 10, in which each apparatus for the protection of medium-voltage lines (in particular, a transformer), which is generically indicated with 15, is applied directly to each pole 13 of the switch 10.

[0024] The switch 10 comprises a switchboard 11 fixed to a support base 12 for the poles 13, each of which essentially consists of an insulating cylinder 17, made from casting resin with gas sealing systems, whereas the protection apparatus 15 in general takes care of the function of protection against current overload, instantaneous and delayed short-circuit and grounding failure.

[0025] Figures 2, 3 and 4, respectively, refer to an embodiment of the compact measurement apparatus for the protection of medium-voltage lines, according to the present invention (generically indicated with 16 in the figures), and to an example of application of such an apparatus 16 in a compartment with a bar switch and disconnecting switch.

[0026] In particular, the apparatus 16, object of the invention, foresees the use of three toroidal transformers 40, 44, 47, one for each phase, which are installed above an attachment support 46 and inside an insulating casing 20, as illustrated in detail in figures 2 and 3.

[0027] The toroidal transformers 40, 44, 47 are combined together and have a core with a substantially large diameter. Moreover, according to the invention, it is foreseen to couple a homopolar transformer, schematically indicated with 39, for the collection of the three phases.

[0028] The homopolar transformer 39 is separated from the other three toroidal transformers 40, 44, 47 by means of a resin insulation and allows the grounding failure current to be detected through the execution of a vector sum of the phase currents.

[0029] Referring, in particular, to figure 4, the compact protection apparatus 16 can be applied with undoubted advantages in a compartment 21 inside of which is housed a bar switch and disconnecting switch, of the tripolar type, according to a preferred but not limiting embodiment of the present invention, generically indicated with 22 in figure 4.

[0030] In such a case, the cables 23 of the medium-voltage line, which are arranged inside an underground passage 24, arrive near to the compartment 21 and pass inside the toroidal transformers 40, 44, 47 of the apparatus 16, which is fixed, inside the compartment 21, to the front of the switch 22.

[0031] One of the medium-voltage cables, specifically indicated with 28 in figure 4, is used as a cable intended for general use and for input for the general power supply of the switchboard 27 attached to the compartment 21 of the bar switch and disconnecting switch 22.

[0032] As can be seen in figure 4, each cable 23, after having crossed the respective toroid, is connected directly to the switch 22, through a specific lower connector 25, whereas a series of signals in output from the toroidal transformers 40, 44, 47 (proportional to the current circulating in the phases) are conducted directly to a protection relay 26 for the switchboard 27. In particular, the three connectors 36, 37, 38, through the respective outputs 41, 42, 43 of the apparatus 16, send the respective phase signals of the toroidal transformers 40, 44, 47 to the protection relay 26 in order to detect the current of the separate phases.

[0033] Moreover, the connector 45, by means of the output 44A, sends a homopolar output signal, taken directly from the homopolar transformer 39, to the protection relay 26 so as to allow the detection of grounding failures.

[0034] The self-powered relay 26, realised in micro-processor digital technology, is placed to protect the maximum current values (biphase or triphase) and operates the opening or switching off of the switch 22 directly on the relative command, in the case of intervention of the protection functions.

[0035] Thanks to the installation of the protection apparatus 16, the correct operation of the entire switching off unit of the switch 22 is guaranteed in the presence of a current greater than or equal to 20% of the nominal value on at least one of the phases.

[0036] Finally, as can be seen clearly in figures 2 and 3, to maximise the compactness of the structure, the protection apparatus 16 is contained entirely inside a single container casing 20 made from thermoplastic material, which rests upon the attachment surface 46, whereas, inside the casing 20, an epoxy resin suitable for the necessary insulation is used.

[0037] In such a way, as well as the possibility of substantially reducing the encumbrance, with respect to known protection devices (regarding which we emphasise the possibility of inserting the entire apparatus 16 object of the invention inside the compartments 21 of bar switches and disconnecting switches, as illustrated in figure 4), there is also greater precision and stability of detected current values and, therefore, a safer intervention, mainly due to the fact that, in such a way, the protection apparatus is no longer installed, like in the prior art, on board the switch.

[0038] In fact this particular arrangement of the apparatus inside compartments allows the problems of interference determined by the electromagnetic flows between toroid and pole to be eliminated, maintaining high electrical characteristics, differentiated uses (for variable current intensities between 40 and 630 A), a compact structure and a substantially low overall production and operating cost, with respect to the prior art.

[0039] Furthermore, the apparatus according to the invention is suitable for detecting current signals to realise overload protection at long reverse time and at adjustable fixed time, short-circuit protection at adjustable independent time and, in general, all maximum phase current protection (instantaneous, with adjustable delay as well as with dependent and fixed time), as well as, possibly, maximum grounding failure current protection (with adjustable delay), calculated as a vector sum of the three primary phase currents and realised by means of the homopolar toroid 39, which processes the phase currents.

[0040] From the description which has been made the characteristics of the compact measurement apparatus for the protection of medium-voltage lines, object of the present invention, are clear, just as the advantages are also clear.

[0041] In particular, they are represented by:

- precision of interventions;
- wide adjustment ranges;

- ensured operation even with monophasic power supply;
- no limitation of the nominal interruption power of the current for a short duration of the switch;
- single and simultaneous adjustment of the three phases;
- constancy and stability of the characteristics, precision and reliability of operation;
- minimal encumbrance, maximum compactness;
- limited cost.

[0042] Finally, it is clear that numerous variants can be brought to the apparatus in question, without for this reason leaving the novelty principles inherent to the inventive idea, just as it is clear that, in the practical embodiment of the invention, the materials, the shapes and the sizes of the illustrated details can be whatever according to the requirements and they can be replaced with others which are technically equivalent.

Claims

1. Compact measurement apparatus (16) for the protection of medium-voltage lines, of the type suitable for picking up electrical signals and for carrying out a series of measurements and processings of said signals, to identify functionalities of malfunctions of the line currents and taking care of possible protection interventions against overload, instantaneous and delayed short-circuit and grounding failure, **characterised in that** said protection apparatus (16) includes in a single insulating container casing (20), a plurality of first toroidal windings (40, 44, 47), one for each phase and arranged in combination with each other, and at least one second winding (39), suitable for collecting the phases of said switch (10), said second winding being separated from said first windings by at least one insulating wall.
2. Compact measurement apparatus (16) according to claim 1, **characterised in that** it can be associated with at least one circuit-breaker relay (26) of the switchboard (27) of a bar switch and disconnecting switch (22), said relay (26) being suitable, upon the basis of the line and grounding current detections, both in nominal conditions and in the presence of disturbances and thanks to suitable procedures controlled by internal microprocessors, to realise active current protection.
3. Compact measurement apparatus (16) according to claim 2, **characterised in that** said current detections are carried out passing a series of cables (23) of the medium-voltage lines inside said first toroidal windings (40, 44, 47), said cables (23) being then respectively connected to said switch (22), through specific lower connectors (25), said meas-

urement apparatus (16) supplying in output a series of first signals proportional to the current circulating in the phases, which are conducted to said circuit-breaker or protection relay (26).

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4. Compact measurement apparatus (16) according to claim 3, **characterised in that** it sends a further homopolar output signal, taken directly from said second winding (39), of the homopolar type, to said protection relay (26) to allow the detection of grounding failures. 10
5. Compact measurement apparatus (16) according to claim 2, **characterised in that** at least one (28) of said cables (23) of the medium-voltage line is used as a cable intended for general use and for input general power supply of said switchboard (27) attached to the compartment (21) of the bar switch and disconnecting switch (22). 15
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6. Compact measurement apparatus (16) according to claim 2, **characterised in that** it foresees a series of connectors (36, 37, 38), which allow the apparatus (16), with its current sensors, to be connected directly to said protection or circuit-breaker relay (26). 25
7. Compact measurement apparatus (16) according to claim 1, **characterised in that** said toroidal windings (39, 40, 44, 47) behave like transformers and have a core with a substantially large diameter. 30
8. Compact measurement apparatus (16) according to claim 1, **characterised in that** said second toroidal winding (39) allows the grounding failure current to be detected, through the execution of a vector sum of the phase currents. 35
9. Compact measurement apparatus (16) according to claim 1, **characterised in that** it is suitable for detecting current signals to realise protection relative to overload at long reverse time and at adjustable fixed time, short-circuit at adjustable independent time, maximum phase current and maximum grounding failure current protection. 40
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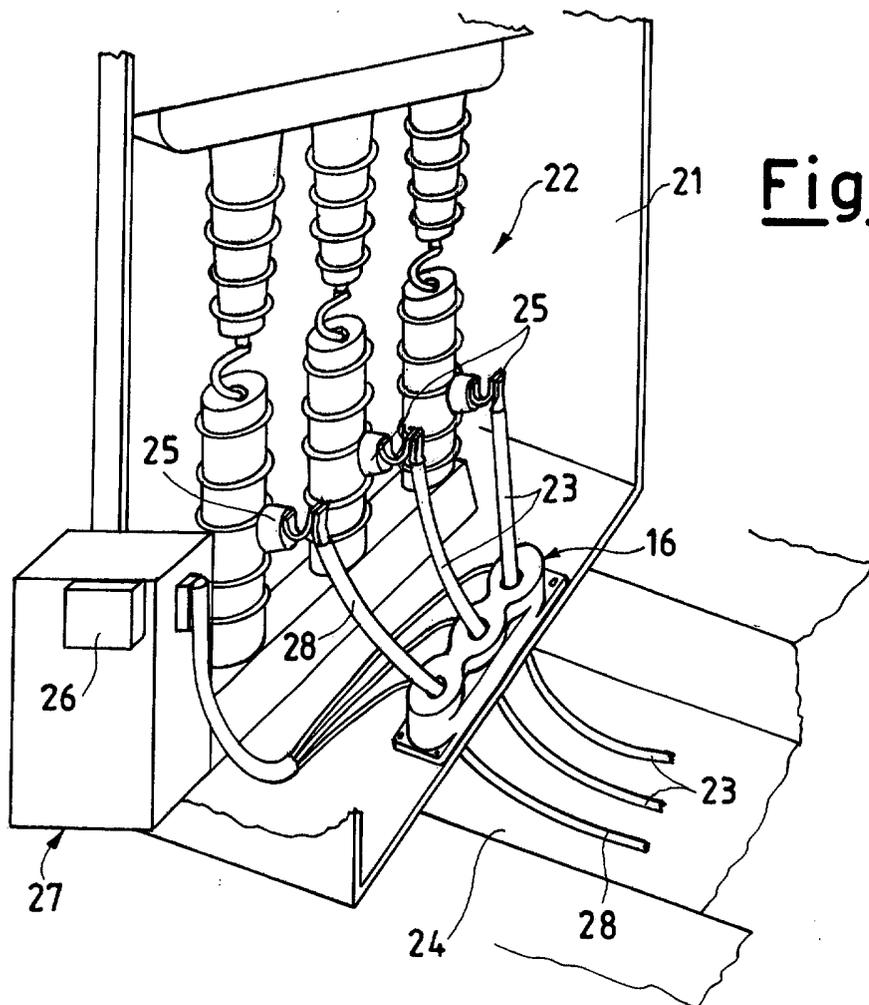
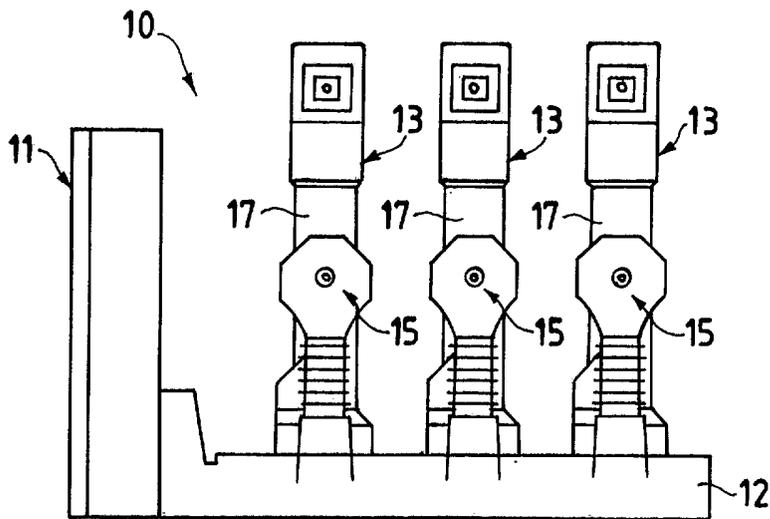


Fig.2

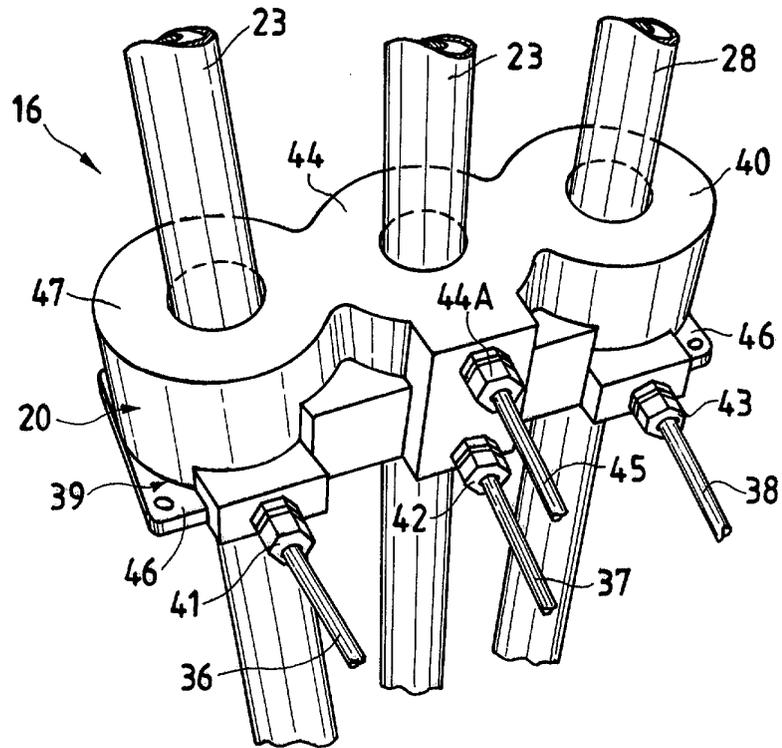
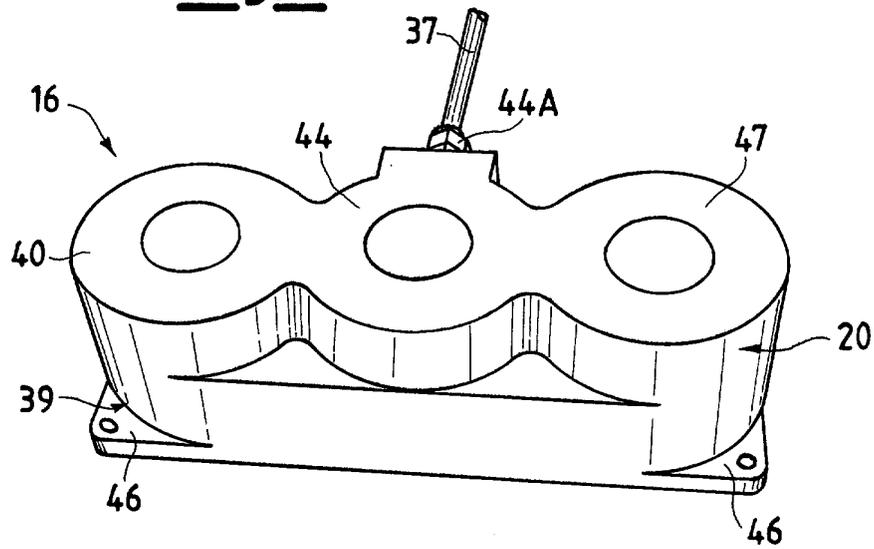


Fig.3





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EUROPEAN SEARCH REPORT

Application Number
EP 02 08 0450

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			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			H01F H02H H01H
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 17 March 2003	Examiner Marti Almeda, R
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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