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SATURABLE REACTOR IMPEDANCE RELAY

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Fig.3

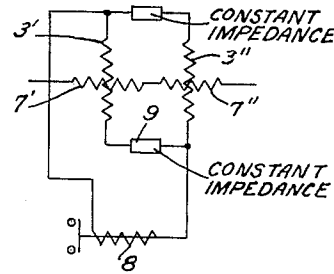


Fig.1

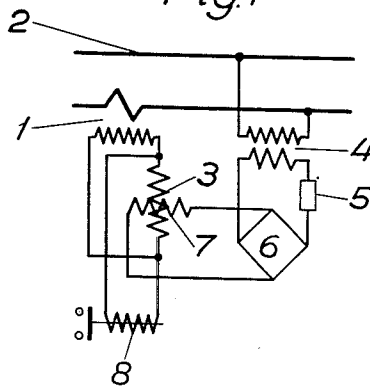


Fig.4

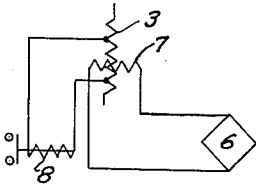


Fig.6

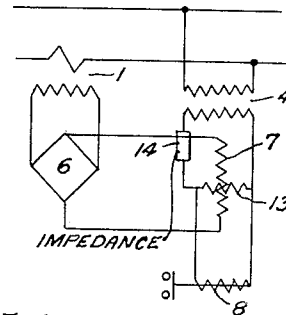


Fig.2

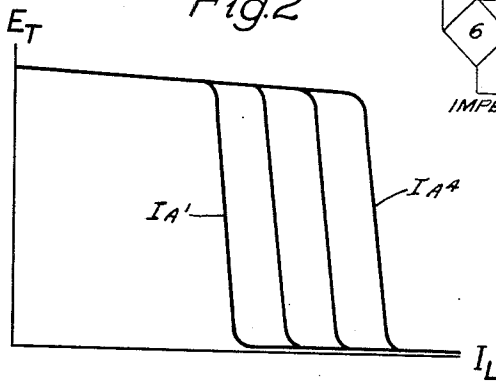
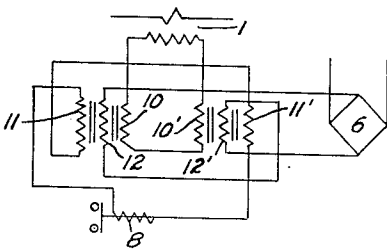


Fig.5



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SATURABLE REACTOR IMPEDANCE RELAY

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5 Claims. (Cl. 175—294)

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A frequently employed protective connection for power installations is, as is well known, based on the principle that on certain points of the installation the proportion between voltage and current is measured, said proportion corresponding on the occasion of a short-circuit to the impedance between the points in question and the point of short-circuit, and that an automatic disconnection is made at the points, where the said proportion is lowest, i. e. next to the short-circuit point. The measuring of the proportion between voltage and current has generally been made in special relays, called impedance relays, which directly or indirectly have released circuit breakers. It has, however, been found that such relays, if they shall be sufficiently accurate and selective, will be rather complicated. Further it has been found that the so-called return ratio of most mechanical relays is rather low so that the value of the releasing quantity, for which the relay has acted, must vary rather considerably, before the relay ceases to act. This may often cause the release of a larger number of circuit breakers than those actuated by the relays which are most adjacent to the point of short-circuit.

The present invention relates to a protective connection for power installations, operating on the aforesaid impedance principles, which connection makes it possible to use very simple relays and further gives a considerably better proportion between the return current and the release current than hitherto employed connections for the same purpose. According to the invention a transducer (a direct current saturable reactor) is fed on the D. C. side by one current and on the A. C. side by another current determined from outside, of which currents one depends on the voltage and the other on the current in the point of the installation, where the protective operation is to be released, while a voltage across the transducer is caused to act on a protective device, generally on a relay releasing a circuit breaker. It is especially advisable to feed the transducer on the D. C. side by a current, dependent on the voltage, and on the A. C. side by a current, depending on the main current, which may for instance be obtained by means of a current transformer. In this case it can be arranged with least possible loss of power so, that the voltage across the transducer is made to rise rapidly at such a proportion between the voltage and current of the line, which gives equal ampere turn numbers on the D. C. and A. C. sides of the transducer, so that even a relay, which is rather little sensitive

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in itself, only reacts for a certain value of the aforesaid proportion.

A form of the invention is diagrammatically illustrated in Fig. 1 of the accompanying drawing, while Fig. 2 shows a diagram of the manner of operation of the transducer employed. Figs. 3 to 6 show diagrammatically other modifications of the invention.

In Fig. 1 the primary winding of a current transformer 1 is connected in a line 2 to be protected, while the secondary winding is connected to the A. C. winding 3 of the transducer, illustrated in the conventional way. The primary winding of a voltage transformer 4 is connected between the conductors of the line, while its secondary winding is connected through an adjusting impedance 5 and a rectifier 6, which may be provided with smoothening members, to the D. C. winding 7 of the transducer. The voltage across the A. C. winding 3 is impressed on the relay 8, which for instance may act to release a circuit breaker.

The voltage conditions of a transducer, the traversing alternating current of which is kept constant by external means, are illustrated by the diagram of Fig. 2. In this diagram the abscissae designate the direct current I_L and the ordinate the voltage E_T across the A. C. winding of the transducer. The different curves IA_1, IA_2 , correspond to different values of the alternating current traversing the transducer.

As long as the magnetizing direct current I_L assuming the same number of turns considerably exceeds the crest value of the traversing alternating current, the transducer absorbs practically no voltage, since its core is permanently saturated. When the transducer is employed as a line protective device according to Fig. 1, this is always the case in normal operation. If, on the contrary, the direct current sinks below the crest value of the alternating current, the voltage E_T across the transducer rises rapidly, because the iron core will then during a larger or smaller part of the cycle be more or less desaturated, so that a voltage can be induced. For a rather small reduction of the direct current the voltage rises to a value, corresponding to a complete reversal of the magnetisation during one cycle, and then it can rise only very little, substantially corresponding to the leakage flux.

The proportion between direct current and alternating current, at which the sudden rise of voltage occurs, corresponds in the connection according to Fig. 1 to a certain proportion between the line voltage and the line current, i. e. at a

short-circuit, to the impedances between the measuring point and the short-circuit point. The connection may thus be so adjusted that the relay 8 will enter into action and release a protective operation as soon as this impedance sinks below a certain value. The adjustment can preferably be made by means of the impedance 5. In certain cases it may be advisable to make this impedance dependent on the voltage, for instance so that the current traversing it rises more rapidly than the voltage. Hereby certain imperfections of the connection illustrated may be compensated, such imperfections arising for instance from the fact that the secondary current of the current transformer 1 is divided between the transducer and the relay coil, whence the transducer current will not be exactly proportional to the main current.

Instead of simply connecting the relay 8 in parallel to a transducer fed by current and voltage, it may be connected in other ways, so as to depend on the voltage across the transducer, for instance as shown in Fig. 3 in a bridge between two opposite corners of a tetragon, in which two opposite sides consist of transducers having A. C. windings 3', 3'' and D. C. windings 7', 7'' and the two remaining ones of constant inductances 9. The two transducers may then have a common core or common cores, if each transducer have two cores in the very usual manner. The connection is preferably so arranged that the bridge conductor normally will carry no current, whereby the action of the relay may be more sensitive than in the simple connection shown in Fig. 1, or alternatively the sensitivity of the transducers for a certain proportion between direct and alternating current may be less. In employing one single transducer it is possible as shown in Fig. 4; to apply to the relay only part of the transducer voltage instead of the entire voltage. In transducers having two cores and the two halves 10, 10' of the A. C. winding connected in series, as shown in Fig. 5, it is also possible to utilize the voltage across third windings 11, 11' connected in the same manner as the D. C. windings 12, 12'. This voltage contains an essential second harmonic, which does not appear to an essential degree before the crest value of the alternating current exceeds the direct current.

It is also possible as shown in Fig. 6 to interchange the functions of the current and voltage transformers in Fig. 1, so that the alternating current of the transducer will depend on the voltage and its direct current on the main current at the point of the installation, where the protective action is to be released. The A. C. winding 13 should in such case be series-connected with an impedance 14, which essentially determines the current therein. It has then full voltage in normal operation, but loses its voltage at a short-circuit through an impedance, corresponding to the adjustment of the protective connection, whence the relay should be

connected in a corresponding manner so as to release the protective action, when its current sinks below a certain value.

I claim as my invention:

1. A protective connection for a power circuit, comprising a direct current saturable reactor, means for feeding the alternating current winding of said reactor directly, rectifier means feeding the direct current winding of said reactor, one of the winding currents being dependent on the voltage and the other on the current in said power circuit, a protective device for such circuit, and means controlled by the voltage across the alternating current winding of said reactor to operate said protective device.

2. In a device as claimed in claim 1, the means for feeding the alternating current winding being dependent on the current in said circuit.

3. In a device as claimed in claim 1, said feeding means feeding the reactor windings with currents proportional to the voltage and current of said circuit.

4. In a device as claimed in claim 1, the means feeding a current dependent on the voltage including a voltage-dependent impedance, whereby the current fed by such means is a non-linear function of the voltage in said circuit.

5. A protective connection for a power circuit comprising two direct current saturable reactors, means for feeding the alternating current windings of said reactors directly, rectifier means feeding the direct current windings of said reactors, one of the winding currents being dependent on the voltage and the other on the current in said power circuit, means connecting the alternating current windings of said reactors in two opposite legs of a bridge, impedances in the other legs of the bridge, a protective device for said power circuit, and means controlled by the voltage from the bridge across the alternating current windings to operate said protective device.

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