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ELECTRICAL PROTECTIVE RELAYS

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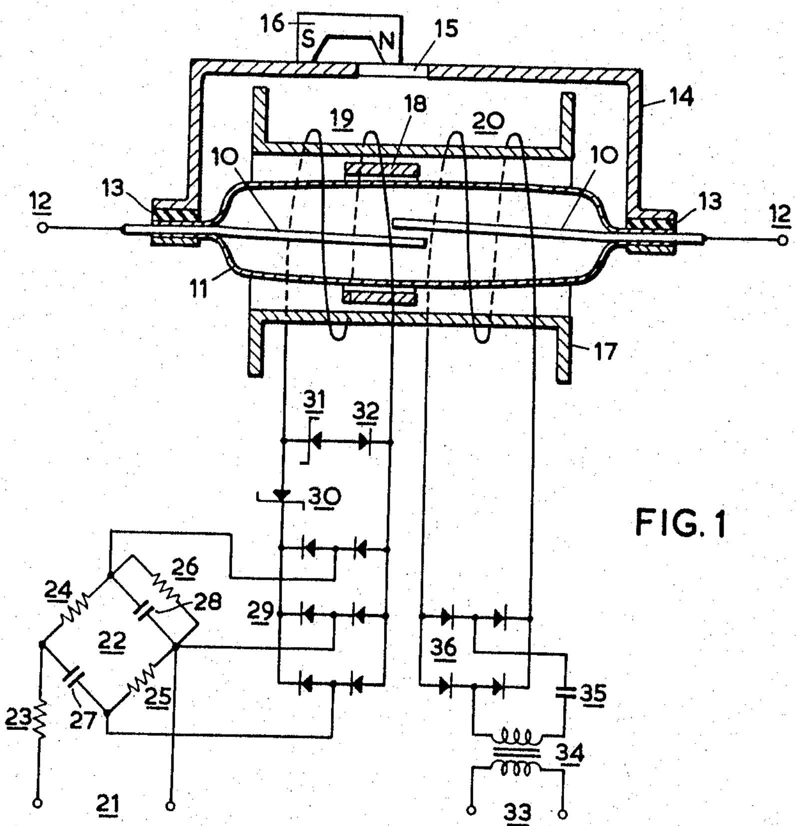

FIG. 1

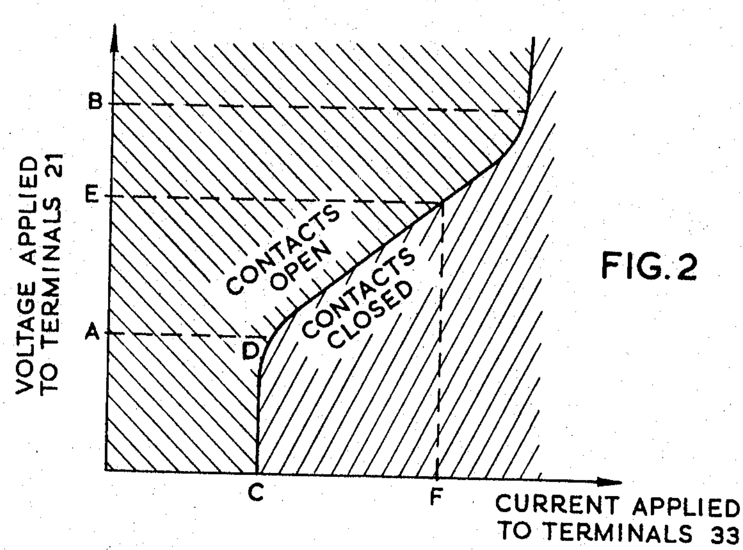

FIG. 2

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ELECTRICAL PROTECTIVE RELAYS

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The invention relates to electrical protective relays.

According to the invention such a relay includes a relay operating element responsive to an operating signal dependent on a current in an electrical system to be protected by the relay and to a restraining signal dependent on a voltage in the system to be protected and arranged to operate at a predetermined ratio of the two signals, means for rendering the element unresponsive to the restraining signal whenever that signal is less than a predetermined intermediate value and means for rendering the element unresponsive to the restraining signal whenever that signal is greater than a second predetermined value substantially higher than the said predetermined intermediate value.

According to a feature of the invention such a relay includes an operating coil effective on energisation by the operating signal to tend to change the operating element from a non-operated condition to an operated condition and an input circuit for supplying the operating coil with the operating signal, this input circuit includes a transformer connected for energisation in accordance with the current in the circuit to be protected, full wave rectifier means for rectifying a current supplied by an output circuit of the transformer to the operating coil.

According to another feature of the invention such a relay includes a restraining coil effective on energisation by the restraining signal to tend to restrain the relay operating element in a non-operated condition, and an input circuit for supplying the restraining coil with the restraining signal, the input circuit including a phase multiplying network responsive to a voltage derived from the system to be protected and for supplying at an output circuit thereof a polyphase system of voltages dependent on the said voltage, a polyphase rectifier means for energisation by the polyphase voltage system produced for supplying a D.C. voltage to the restraining coil, a constant voltage device connected between the rectifier network and the restraining coil so as to prevent energisation of the coil until the restraining signal exceeds the said predetermined intermediate value and a second constant voltage device connected across the restraining coil whereby to limit the voltage developed across the coil by the restraining signal so that the operating element is unresponsive to values of the second restraining signal which are in excess of the said predetermined value substantially higher than the said predetermined intermediate value.

According to another feature of the invention in such a relay the relay operating element may be a normally open reed type contact member system having the operating and restraining coils wound about the contact member system and a magnetic system for causing a predetermined low flux to exist between the normally open contact members, the operating coil being arranged when energised to assist the magnetic system whereby to cause the contacts to close and the restraining coil being arranged when energised to oppose the magnetic system whereby to oppose the closure of the contacts.

Alternatively, the relay operating element comprises a normally-open reed type contact member system having the operating and restraining coils wound about the contact member system and a magnetic system for causing a

predetermined high flux to exist in the contact members whereby to maintain the contacts in a closed position, the operating coil being arranged when energised to oppose the magnetic system whereby to cause the contacts to open and the restraining coil being arranged when energised to assist the magnetic system whereby to oppose the opening of the contacts.

One reed type electromagnetic protective relay according to the invention will now be described by way of example and with reference to the accompanying drawing in which:

FIG. 1 shows diagrammatically the arrangement and the electric circuit connections of the relay, and

FIG. 2 shows the operating characteristic of the relay.

Referring now to the drawing, an electric circuit comprises two resilient contacts **10** of material having low magnetic remanence biased to an open position and enclosed in a non-reactive atmosphere within an envelope **11**, and external terminals **12**.

A magnetic circuit comprises contacts **10**, electrically insulating pieces **13**, a U-shaped member **14** of material having low magnetic remanence and having in part of its length a region **15** of reduced cross-sectional area. A permanent magnet **16** movable horizontally (as shown in the drawing) is arranged in contact with the member **14**. Means are provided (not shown in the drawing) for moving and restraining the magnet between two extreme positions which are respectively where both poles of the magnet are left of the region **15**, and where one pole of the magnet is left of the region **15** and the other pole of the magnet is right of the region **15**.

The envelope **11** is surrounded by a non-magnetic former **17** on which two coils **19** and **20** are wound. A metallic slug **18** comprising of a cylindrical ring is provided to reduce chatter of the relay contacts.

Terminals **21** for connection with the output winding of a voltage transformer (not shown in the drawing) supply a bridge network **22** through a resistor **23**. This bridge network comprises of resistors **24**, **25** and **26** and capacitors **27** and **28**, the component values being so arranged to provide a three phase output signal from a single phase input signal. This output circuit is connected through a 3-phase full-wave rectifier **29** and zener diode **30** to the coil **19**. A zener diode **31** is connected in series with a rectifier **32** across the coil **19**.

Terminals **33** for connection with the output winding of a current transformer (not shown in the drawing) supply a primary winding of a saturable transformer **34**. A secondary winding of this saturable transformer supplies the coil **20** through a capacitor **35** and a single phase full-wave rectifier **36**.

In operation, the magnet **16** is adjusted so that the contacts just open when no current flows in the coils **19** and **20**. The terminals **21** are connected for energisation to an output winding of a voltage transformer whose input winding is connected for supply across an electrical system which is to be protected by the relay. Likewise, the terminals **33** are connected for energisation to an output winding of a current transformer whose input winding is connected in series with the system to be protected. When the relay is so energised the magnetic fields produced respectively by coils **19** and **20** act in opposition, the field of coil **20** tending to close the contacts. Zener diode **30** is arranged so that when the voltage applied to terminals **21** lies below a predetermined intermediate value A, see FIG. 2, no current will flow in coil **19**. At a predetermined higher voltage value B zener diode **31** conducts so that the current flowing in coil **19** cannot increase substantially above a certain value. Between the said predetermined value and the said predetermined higher value the magnetic field produced by coil **19** varies in dependence on the value of the voltage across terminals **21**. Thus in the operating range between the voltage A and B the operation of the contacts is dependent on the simultaneous values of the input to terminals **21** and the input to terminals **33**. Below the value A and above the value B, the operation of the contacts is dependent solely on the input value of terminals **33**, though current value C is the minimum value required to cause the contacts to close. Hence the lower boundary for operation of the contacts is defined by the line CD.

The voltage value E represents normal operating voltage of the system to be protected and current value F represents approximately 1.5 times normal system current. The operating characteristic shows that for any combination of voltage and current values producing on FIG. 2 an intersection lying to the right of the characteristic, operation of the relay occurs, and hence the characteristic indicates how the relay operates for normal faults as well as for faults where the system current may be lower than normal rated current when the system voltage is low or very low and for faults, where both the system voltage and the system current may be excessively high. The phase multiplying circuit renders the operation of the relay substantially independent of the phase angle between the system voltage and the system current.

If the input to terminals **21** is suddenly reduced at a time when capacitor **28** is fully charged resistor **26** provides discharging means for the said capacitor which would otherwise discharge more current through the coil **19** and increase the operating time of the relay contacts. Resistor **26** is not essential to the operation of the bridge network **22**.

Rectifier **32** prevents the flow of current in a direction which may increase the operating time of the relay by maintaining the magnetic field produced by coil **19** when the supply from the rectifier network **29** suddenly decreases.

In a modification, a resistance is connected across rectifier **32** to provide equivalent action to that of metallic slug **18** as an alternative to the use of a metallic slug **18**.

In another modification, the zener diode **30** is replaced by any equivalent impedance device.

In another modification, the magnet is adjusted so that the contacts are closed when no current flows in the coils **19** and **20**, so that on energisation of the coils the contacts open when the magnetic flux in the contacts falls to a predetermined low value.

In a further modification, the relay may be provided with several separate coils dispersed around the contact system so that on energisation of the coils a magnetic field may be produced to cause the contacts to open or close as the case may be.

It will be appreciated that the magnet, or any other magnet similarly located, provides a simple means for fine adjustment of the operating characteristics of the contacts and may be used with any contact system which operates in dependence on a change of magnetic flux in the contact system and is in no way limited to reed-type contacts.

A multiple contact system in which two members of the contact system suitably arranged are influenced to operate in dependence on a change of a magnetic flux in the two members may also be used.

What I claim as my invention and desire to secure by Letters Patent is:

1. A protective relay for an electrical system comprising,

a first circuit device for developing a first signal dependent on the current in said system,

a second circuit device for developing a second signal dependent on the voltage of said system,

a relay element,

first control means for applying the first signal to said element in a sense tending to operate the element when its magnitude exceeds a certain finite value,

second control means for applying the second signal to said element in a sense tending to restrain its operation,

circuit means for protecting said system in response to the operation of said element in dependence on the relationship between the magnitudes of the first and second signals and

limiting means for inhibiting the application of said second signal to said element whenever it lies below a predetermined low value and restricting the maximum magnitude of this signal to a predetermined higher value.

2. A protective relay according to claim **1**, wherein said limiting means comprises

a first voltage-dependent switch connected in series with said second control means and having a critical voltage breakdown at said predetermined low value, and

a second voltage-dependent switch connected in parallel with said second control means and having a critical voltage breakdown at said predetermined high value.

3. A protective relay according to claim **2**, wherein said second circuit device comprises

a phase multiplier responsive to the voltage of said system, and said second control means comprises

a full-wave rectifier connected to said phase multiplier for developing a smooth direct potential therefrom.

4. A protective relay according to claim **2**, wherein said relay element comprises

an electromagnetic relay having

co-operating contacts connected in series with said circuit means,

a first winding embracing said contacts and connected to receive said first signal and

a second winding embracing said contacts and connected to receive said second signal.

5. A protective relay according to claim **4**, comprising means for bridging the co-operating contacts and completing a magnetic circuit therefor, the bridging means comprising

a permanent magnet movable to adjust the reluctance of the magnetic circuit.

6. A protective relay for an electrical system comprising

a first circuit device for developing a first signal proportional to the current in the said system,

a second circuit device for developing a second signal proportional to the voltage of said system,

an electromagnetic relay having

a pair of co-operating contacts

a first winding energisable to close said contacts and effect protective action and

a second winding energisable to restrain closure of said contacts

first control means for applying the first signal to said first winding in response to said signal exceeding a certain finite value.

second control means for applying the second signal to said second winding whereby said contacts are operated in dependence on the ratio of the first to the second signals, and

voltage-limiting means for inhibiting the application of said second signal to the second winding whenever it lies below a predetermined low value and restricting the maximum magnitude of this signal to a predetermined higher value.

7. A protective relay according to claim **6**, wherein said first circuit device comprises

a saturable current transformer responsive to the system current and for protecting said first winding from overcurrents, and wherein said second circuit device comprises

a phase multiplier responsive to the system voltage and for rendering the operation of the relay contacts substantially independent of the phase angle between the system voltage and current.

8. A protective relay according to claim 6, wherein said electromagnetic relay is a reed-type relay, and includes

magnetic means for bridging the co-operating contacts and completing a magnetic circuit therefor, the magnetic means comprising

a permanent magnet movable to vary the reluctance of said magnetic circuit and thereby adjust the operating characteristics of said relay.

9. A protective relay for an electrical system comprising

a current transformer responsive to the system current and operable to develop a first signal proportional thereto,

a phase multiplier responsive to the system voltage and operable to develop a second signal proportional thereto,

a reed relay having

a pair of co-operating contacts,

a first winding energisable to close said contacts and effect protective action and

a second winding energisable to restrain closure of said contacts,

first control means for applying the first signal to said first winding in response to said signal exceeding a certain finite value,

second control means for applying the second signal to said second winding whereby said contacts are operated in dependence on the ratio of the first to the second signals,

a first zener diode connected in series with the second winding for inhibiting the application of said second signal thereto whenever it lies below a predetermined low value and

a second zener diode connected in parallel with said second winding for restricting the maximum magnitude of said second signal to a predetermined higher value.

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