

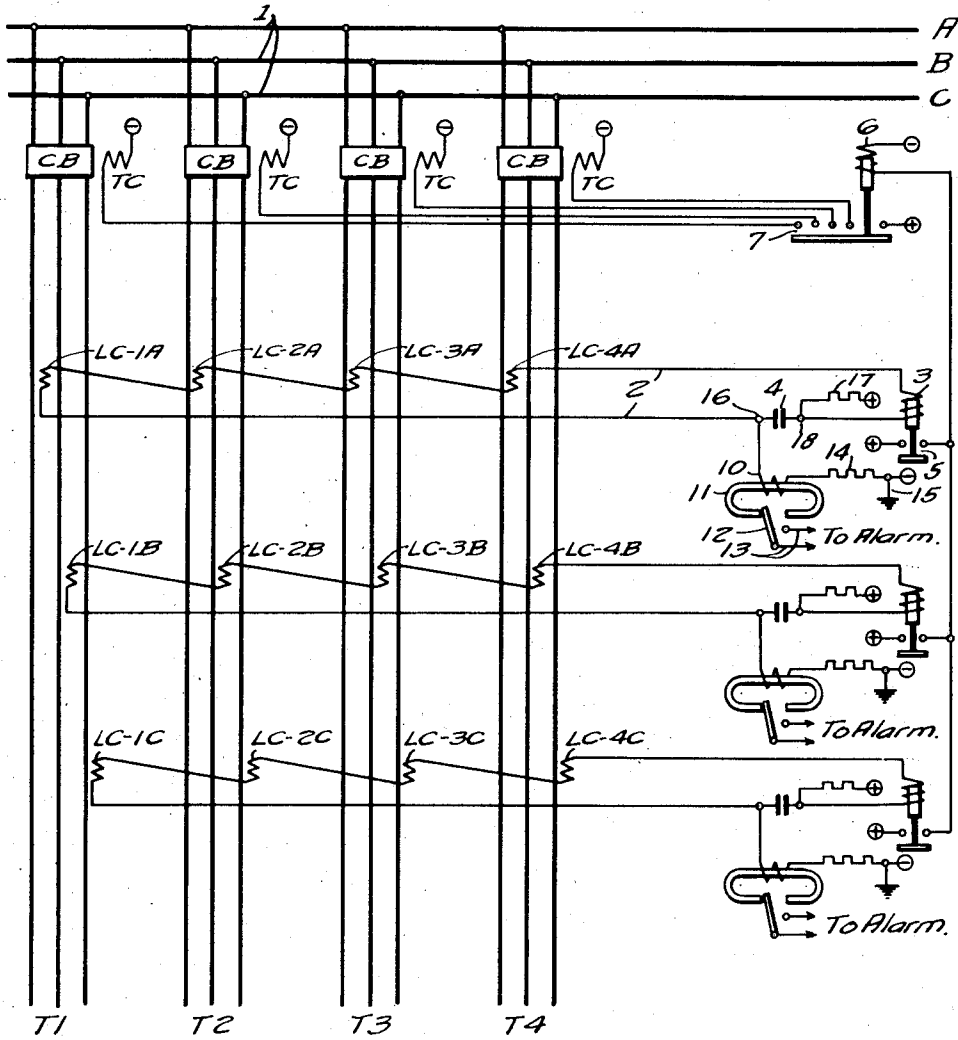
Dec. 11, 1945.

E. L. HARDER

2,390,788

LOOP-CIRCUIT SUPERVISORY SYSTEM

Filed Oct. 20, 1943



WITNESSES:

E. A. M. C. Loskey

INVENTOR

Edwin L. Harder.

BY *O. B. Buchanan*

ATTORNEY

UNITED STATES PATENT OFFICE

2,390,788

LOOP-CIRCUIT SUPERVISORY SYSTEM

Edwin L. Harder, Forest Hills, Pa., assignor to
Westinghouse Electric Corporation, East Pitts-
burgh, Pa., a corporation of Pennsylvania

Application October 20, 1943, Serial No. 506,968

2 Claims. (Cl. 177-311)

My invention relates to a supervisory system for a loop-circuit, particularly for the supervision of a series-loop protective-circuit through a plurality of linear couplers associated with the respective terminals of a multi-terminal bus or other alternating-current apparatus to be protected. A linear coupler is a voltage-producing current-responsive means which produces a relaying voltage proportionate to the current in the terminal-conductor with which it is associated. An example of such a linear coupler is to be found in my Patent 2,241,127, granted May 6, 1941.

The importance of the supervision of the protective circuits of important lines and buses is now so well recognized that it is perhaps unnecessary to point out this need. Since the linear-coupler system is primarily adapted for the protection of important buses, the importance of supervising the series loop-circuit which runs from coupler to coupler will readily be appreciated. Heretofore, a bridge system of supervision has been devised for the automatic supervision of such circuits, in addition to a manual supervision-system which required the operation of a push-button by the operator. In many cases, however, it is not feasible to apply the bridge type of supervision, and hence the need has been felt for some other type of automatic supervision of the loop-circuit.

It is an object of my invention to provide an improved supervised loop-circuit for linear couplers, characterized by having a serially connected capacitor in the loop-circuit, and a direct-current supervisory source and relay connected in shunt around the capacitor.

A further object of my invention is to provide a novel kind of supervisory means for an alternating-current loop-circuit, for detecting both grounds and open-circuit in the loop-circuit.

With the foregoing and other objects in view, my invention consists of the apparatus, parts, combinations, systems and methods hereinafter described and claimed, and illustrated in the accompanying drawing, the single figure of which is a diagrammatic view of circuits and apparatus embodying my invention in an illustrative preferred form of embodiment.

I have illustrated my invention as being utilized in connection with the protection of a polyphase bus 1, the various phase-conductors of which are indicated by the letters A, B and C. The bus is illustrated as having four polyphase terminals, connected to as many feeders or polyphase lines T₁, T₂, T₃ and T₄, through circuit

breakers CB which are illustrated as being provided with trip-coils TC whereby the several breakers may be opened. Each phase of each of the bus-terminals has inductively associated therewith a linear coupler LC, or other voltage-producing current-responsive means for deriving a voltage which is, in each case, a substantially identical predetermined function of a terminal-current of the apparatus, times an impedance which is substantially constant for all obtainable current-values and which is substantially the same for all terminals. In actual practice, the linear couplers LC may conveniently be associated with the terminal-bushings (not shown) of the respective circuit-breakers CB. The various couplers are distinguished by suffixed numerals and letters indicative of the particular terminal and phase with which the coupler is associated.

I have illustrated my invention in connection with a three-phase bus, in which it is desirable to have separate summation-means for each of the phases of the bus, for securing an indication of the vectorial sum of all of the currents entering that phase of the bus, in all of the terminals thereof, so as to obtain an indication of an internal fault on the bus in case the vectorial sum of these terminal currents, of that phase, should become other than zero. Since the linear coupler is a voltage-producing device, rather than a current-producing device, as is the case with ordinary current-transformers, the summing-means takes the form of a series loop, 2, for each phase.

Since the protective devices for the different phases are all alike, my description will be more specifically directed to the phase-A loop-circuit 2, which includes the four phase-A linear couplers LC-1A to LC-4A. The loop-circuit 2 includes an alternating-current energy-translating means, in the form of the operating coil of a fault-detective relay 3. In accordance with my invention, the loop-circuit 2 also serially includes a capacitor 4, which is useful, not only as a means for applying my supervisory means, which will be subsequently described, but also as a means which may be utilized to approximately tune the loop 2, or to more or less perfectly neutralize, or compensate for, or even to overcompensate for, the reactance of the entire loop-circuit, thus reducing the volt-ampere burden on the respective linear couplers.

The fault-detective relay 3 is provided with a make-contact 5 which is utilized to energize a tripping relay 6 having contacts 7 which ener-

gize the respective trip-coils TC of all of the circuit breakers CB, so as to open all of the terminals of the bus 1, in the event of a fault on any phase of the bus.

In accordance with my invention, the series capacitor 4 of the loop-circuit 2 is shunted by means of a supervisory circuit which includes the operating coil 10 of a polarized supervisory relay 11, or other sensitive direct-current relay, having a drop-out contact-member 12 which is utilized to energize an alarm-circuit 13 when the operating coil 10 is insufficiently energized, the supervisory relay 11 being shown in its energized position.

The supervisory circuit which shunts the series capacitor 4 includes, in addition to the operating coil 10 of the supervisory relay 11, a direct-current source which is indicated by its terminals (-) and (+). Preferably, that portion of the supervisory circuit which includes the supervisory-relay coil 10 has a high resistance, which is indicated, in the diagram of the drawing, as being a separate resistor 14, having a resistance which is so high that the supervisory current, which is superimposed upon the loop-circuit 2, is far below the level of sensitivity of the fault-detective relay 3, so that the action of the fault-detective relay 3 will not be at all affected by the tiny circulating direct current. The supervisory circuit is preferably grounded between the resistance 14 and the adjacent battery-terminal (-), as indicated at 15.

Thus, the entire supervisory circuit may be regarded as including, first, a circuit means for connecting one terminal of the high-resistance portion 10-14 of the supervisory circuit to the loop-circuit 2, on one side of the capacitor 4, as indicated at 16; also another circuit-means, including a resistor 17, for connecting one battery-terminal (+) to the loop-circuit on the other side of the capacitor 4, at a point indicated at 18; and also circuit-means for connecting together, and grounding, the other terminal of the high-resistance portion 10-14 and the other battery-terminal (-), as indicated at 15. In this manner, the loop-circuit 2 operates at a direct-current supervision-voltage above ground, said voltage being the voltage of the supervisory battery or other direct-current source indicated by the terminals (+) and (-), minus the voltage-drop in the resistor 17.

In operation, the capacitor 4 is introduced in order to complete the alternating-current loop-circuit, and still open the loop so that a small direct-current can be introduced in the loop for supervising purposes. In the previously known bridge-type system of automatic supervision, it was not possible to utilize a series capacitor, because it was necessary for the supervised direct-current to be able to flow throughout all portions of the supervised circuit, and hence it was not possible to obtain the additional advantage of the cancellation of inductive reactance, which is made possible by the introduction of the series capacitor.

In normal operation, the battery, indicated by the terminals (+) and (-), circulates a tiny supervisory direct-current through the high resistance 14, the supervisory-relay coil 10, and the entire loop-circuit 2 other than the capacitor 4, that is, through each of the four linear couplers LC-1A to LC-4A, and through the operating coil of the alternating-current protective relay 3. In case this loop-circuit should become broken or open-circuited at any point, this flow of the

tiny supervisory direct current will be interrupted, the supervisory relay 11 will be deenergized, and its contact-member 12 will close, to energize the alarm-circuit 13.

My provision of the high resistance 14 and the ground-connection 15, in the supervisory circuit, also makes it possible to utilize the same supervisory relay 11 to respond to a grounded condition of any portion of the supervised loop-circuit 2. This is true, because the impedance of the portion 10-14 of the supervisory circuit which includes the supervisory-relay 10 has a very considerably higher resistance than the portion 17 of the supervisory circuit including the direct-current source which is represented by the battery terminals (+) and (-), and because the battery-portion of this circuit is directly connected, through a relatively small resistance 17, between the loop-connection at 18 and the ground-connection at 15.

Consequently, if any portion of the loop-circuit 2 should become grounded, the battery-containing portion 17 of the supervisory circuit would become short-circuited, or its circuit would become completed through a resistance 17 which is very low as compared to the resistance 14, assuming that the resistance 14 is much higher than the resistance of any grounding circuit in the event of a ground on the loop-circuit 2. The effect of this short-circuiting of the supervisory battery-source, as a result of a ground on the protected loop-circuit 2, will thus be to substantially completely deenergize the supervisory relay 11, thus causing its drop-out contacts 12 to close, the same as would be the case in the event of an open circuit within the protected-loop-circuit 2. The resistance 17 is of such value that a ground-fault on the loop 2 cannot draw sufficient direct current to trip the protective relay 3.

While I have indicated but a single illustrative form of embodiment of my invention, I wish it to be understood that my invention is susceptible of various alterations, by way of modifications, additions and omissions, within the skill of the mechanic, and I desire that the appended claims shall be accorded the broadest construction consistent with their language.

I claim as my invention:

1. Supervisory means for an alternating current loop-circuit including alternating-current energy-translating means and a capacitor serially included in said loop-circuit, said supervisory means including a supervisory circuit in shunt-circuit relation to said capacitor, said supervisory circuit including a direct-current source and a supervisory relay-means, said supervisory relay-means including means for responding to a faulty condition within said loop-circuit, the portion of said supervisory circuit which includes said supervisory relay-means having a high resistance, so high that the supervisory current is far below the level of sensitivity of the alternating-current energy-translating means of the loop-circuit, means for connecting one terminal of said high-resistance portion of the supervisory circuit to the loop-circuit on one side of the capacitor, means for connecting one terminal of said direct-current source to the loop-circuit on the other side of the capacitor, and means for connecting together, and grounding, the other terminals of said high-resistance portion and said source.

2. Supervisory means for an alternating-current loop-circuit including alternating-current energy-translating means and a capacitor serially included in said loop-circuit, said supervisory

means including a circuit-portion of relatively high resistance, including a supervisory relay-means for responding, by drop-out action, to a faulty condition of said loop-circuit, said high-resistance circuit-portion being connected between one terminal of the capacitor and ground, and a second circuit-portion, having a lower resistance and including a source of supervisory current, connected between the second terminal of the capacitor and ground, said lower resistance

being of such value that a ground-fault on the loop-circuit cannot draw sufficient supervisory current to actuate the alternating-current energy-translating means of the loop-circuit, and the resistance of the high-resistance circuit-portion being so great that a ground-fault on the loop-circuit causes the supervisory relay-means to drop out.

EDWIN L. HARDER.