

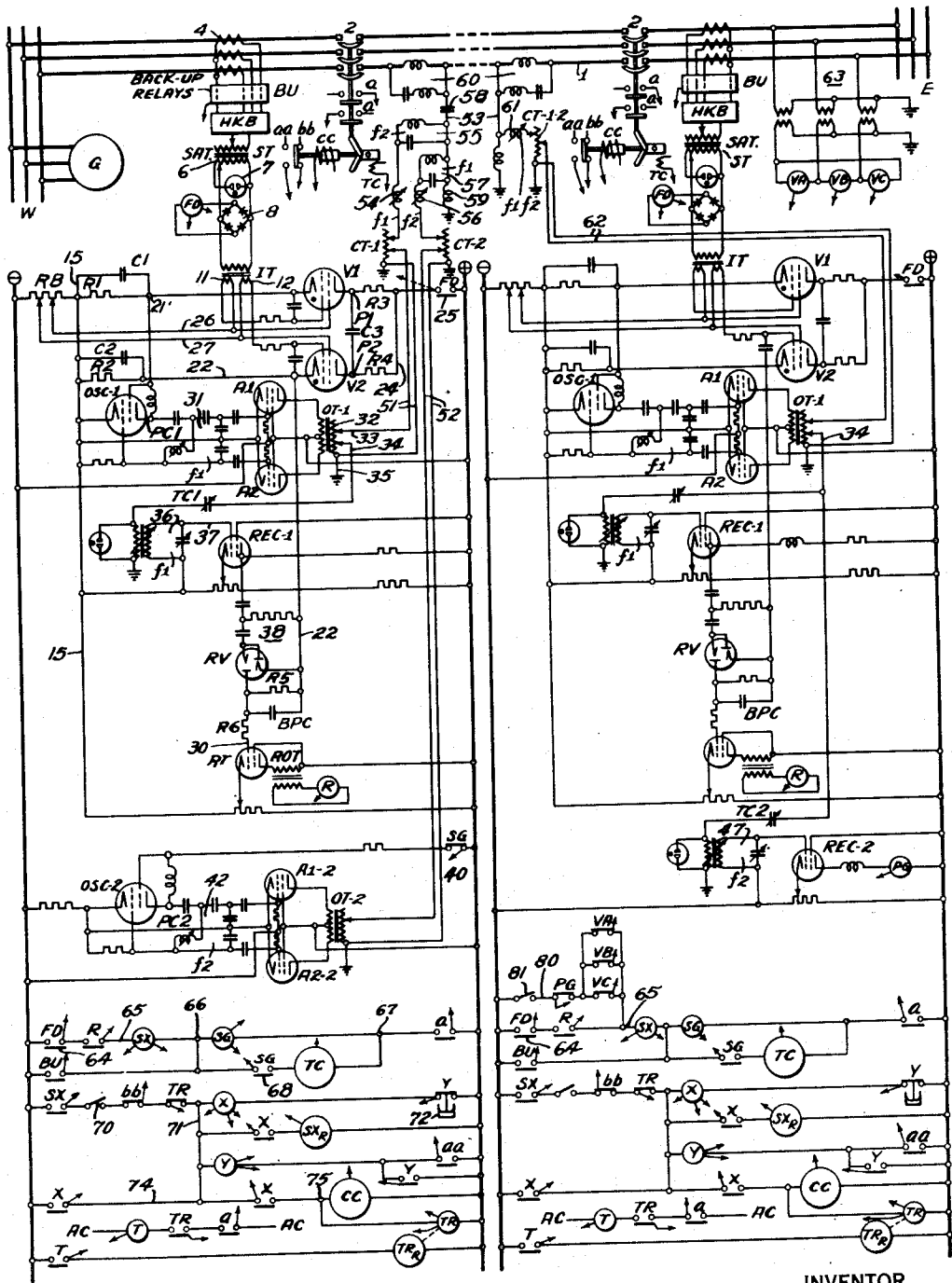
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TRANSFER-TRIPPING CARRIER-CURRENT RELAYING-SYSTEMS

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TRANSFER-TRIPPING CARRIER-CURRENT
RELAYING SYSTEM

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My invention relates to transfer-tripping carrier-current relaying-systems, and it has particular relation to the use of transfer-tripping carrier-current relaying-means as an adjunct to the prompt or instantaneous reclosure of circuit-breakers. My invention has more particular relation to the protection of a transmission-line section which extends between two electrical buses located at different stations or places, under transmission-line operating-conditions in which one of the buses is a part of a large-capacity system, so that it will supply sufficient fault-current, to a fault, for a reliable instantaneous fault-determination at that terminal, whereas the other bus, at the other end of the protected line-section, is connected to a large load, with little spinning-capacity, so that, under some or all generating-conditions, this bus will have insufficient fault-current-supplying capacity for reliable instantaneous fault-determination at this terminal.

It is usually or frequently desirable to reclose the circuit-breakers of a transmission-line, promptly or instantaneously after a circuit-breaker tripping-operation which has been obtained as a result of an instantaneous fault-response. This reclosing-operation is desirable, in order to restore the protected line-section to service as quickly as possible, and it is made possible by the fact that most faults are arcing-faults which will clear themselves very promptly upon the removal of all voltage from the faulted line-section, so that the faulted line-section will be practically immediately ready for restoration to service, after this voltage-removal. It is necessary, however, for both ends of a faulty line-section to be disconnected from the rest of the transmitting system. In systems of the type in which insufficient fault-energy is being supplied, at one end, for reliable instantaneous fault-response or fault-determination, it has heretofore been impossible ever to promptly or instantaneously reclose the circuit-breakers of the line-section in question, because of the impossibility of knowing, at the large-capacity bus, whether the line had been disconnected at the low-capacity bus.

The principal object of my invention is to provide a novel carrier-current means whereby the foregoing difficulties may be avoided.

A more specific object of my invention is to provide a normally continuously transmitting carrier-current transmitting-means, at the large-capacity terminal, for transmitting, to the other end of the protected line-section, during nor-

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mal fault-free operating-conditions within the protected line-section, a continuous distinctive carrier-current signal denoting the continuance of a fault-free condition within the protected line-section, as determined at said large-capacity terminal, this continuous carrier-current transmission being stopped in response to a tripping-relay operation at the large-capacity terminal of the protected line-section, and this stoppage of carrier being utilized, at the low-capacity terminal, for effecting an instantaneous tripping-operation at said low-capacity terminal.

With the foregoing and other objects in view, my invention consists of the systems, circuits, apparatus, combinations, parts and methods of design and operation hereinafter described and claimed, and illustrated in the accompanying drawing, the single figure of which is a much simplified diagrammatic view of the essential circuits and apparatus necessary to illustrate the novel features of my invention as applied to an illustrative protected line-section.

In the drawing, I have illustrated my invention as being applied to the protection of a three-phase transmission-line section 1, which is connected between a large-capacity west station, which is symbolized by a three-phase electrical bus W having a large generator G connected thereto, and a small-capacity east station, which is represented by a three-phase electrical bus E. In the following explanations, it will be assumed that the east bus E carries a large load, with little spinning-capacity, so that, in general, it will have, or is likely to have, insufficient capacity to supply enough fault-current for reliable instantaneous fault-response discrimination at said east substation or terminal of the protected line-section 1.

In the drawing, I have shown the protective terminal-equipment for both terminals of the protected line-section 1. While these two protective terminal-equipments are dissimilar, in important details which will be subsequently described, much of the terminal-equipment is identical, at both ends of the protected line-section, so that a description of the equipment at one end, say the west end, will suffice for both ends, provided that any differences, between the two ends, are noted as the description progresses, as will be done.

Referring particularly to the west end of the protected line-section 1, it will be noted that the line-section is connected to the station-bus W, at this end, by means of a circuit-breaker 2, which is shown as being provided with latched tripping

and closing mechanisms, under the control of a trip-coil TC, and a closing-coil CC, respectively. The breaker 2 also has two pole-operated auxiliary make-contacts *a*, which close when the main breaker-contacts close, a mechanism-operated make-contact *aa*, which closes in the operative or closed position of the breaker-operating mechanism, and a mechanism-operated back-contact *bb*, which closes in an early part of the opening movement of the breaker-operating mechanism.

The various relays which make up the protective relaying-system, as shown in the drawing, include various relays which are shown, so far as practicable, after the manner of a schematic or "across-the-line" diagram, which results in the various relay-coils and relay-contacts being located, according to their circuits, at separated places in the drawing. In each case, the main or operating-coil of the relay is given a letter-designation or legend, and the same letter-designation or legend is applied to all of the contacts of that relay. When a relay is provided with a reset-coil, the reset-coil is distinguished by a subscript R following the letter-designation of the relay. Arrows or dotted lines are also used, to symbolically indicate how the various parts of each relay are connected together. The relays and switches are invariably shown in their open or deenergized positions.

In its broadest aspects, my invention contemplates the installation of fault-responsive relays, at each of the line-terminals, which respond only to internal fault-conditions, that is, to a condition in which there is a fault within the protected line-section 1, somewhere between the two terminal buses W and E. These internal-fault relays, in the broadest aspects of my invention, may be instantaneous or quick-acting relays, and they may even be time-delayed relays, but in general, they will be instantaneous or non-delayed relays, having no substantial delays in their operating-times, and in general also, these relays will be carrier-supervised relays, which rely upon a carrier-responsive blocking-means for blocking an instantaneous fault-response of the local fault-responsive protective-means, this blocking-action being obtained by means of carrier-current which is transmitted, only at times of fault, from the other end of the protected line-section, these transmitted carrier-current signals being utilized to distinguish between internal faults, located somewhere within the protected line-section, and external faults located somewhere beyond one end of the protected line-section.

There are two successful carrier-current relaying-systems, in general use today, and either one may be used, in my present invention, for the instantaneous fault-responsive relays which respond selectively and reliably to internal faults within the protected line-section. One of these two carrier-current systems is the directional-comparison system which obtains a local line-current directional-indication at each of the line-terminals, and transmits information as to the local directional determination, whether internal or external, by means of carrier-current signals transmitted to the other terminal, as shown, for example, in my Patent 2,416,677, granted March 4, 1947, and in many other patents. The other generally accepted carrier-current system, for reliably responding to internal faults within the protected line-section, is the so-called phase-

comparison system, which is the one which I have chosen for illustration in connection with my present invention. The general features of the illustrated type of phase-comparison system are shown in the Mehring Patent 2,408,868, granted October 8, 1946. In this system, a fault-detector initiates the transmission of carrier-current impulses during line-current half-cycles of one polarity, and operating-impulses for a local relay during line-current half-cycles of the opposite polarity, utilizing carrier-current impulses, received from the opposite line-terminal, for blocking a response to the operating-impulses, under "through" line-current conditions.

As shown in the drawing, I utilize a bank of line-current transformers 4, at each terminal of the protected line-section 1, to derive, or respond to, the three-phase line-current. This line-current is supplied first to some back-up relays, which are symbolically indicated by a rectangle marked BU, because these relays may be of any known or conventional form, their precise details being immaterial to my present invention. After passing through the back-up relays BU, the derived line-current is then applied to any suitable network or filter, which is marked HKB, for deriving a single-phase alternating-current voltage which is applied to the primary winding of a saturable transformer ST. The output-voltage of the HKB network is responsive to a plurality of kinds and severities of faults, on whatever line-phase a fault may occur, as broadly covered by the Harder Patent 2,183,646, granted December 19, 1939. The secondary winding 6 of the saturable transformer ST is shunted by a voltage-limiting gas-filled tube 7, as described in the Harder patent. The secondary winding 6 also energizes the operating-coil FD of a fault-detector, which is illustrated as being energized through a rectifier-bridge 8. The secondary winding 6 is further used to energize the primary winding of an input-transformer IT, which is used to control the phase-comparison carrier-current relaying-system which is shown in my accompanying drawing.

The input-transformer IT has two secondary windings 11 and 12, which are utilized to control the grid-circuits of two alternately triggering gas-filled tubes V1 and V2. The cathode-circuits of these gas-tubes V1 and V2 include a biasing resistor RB, one terminal of which is connected to the negative bus (—) of a direct-current voltage-source for the tubes, while the other terminal of said resistor is connected to a conductor 15, which is utilized for several purposes. The circuit 15 is used to energize one terminal of a cathode-circuit loading-resistor R1, the other terminal of which is connected to the cathode-terminal 21 of the first gas-tube V1. The circuit 15 is also used to energize one terminal of another cathode-circuit loading-resistor R2, the other terminal of which is connected to the cathode-circuit 22 of the second gas-tube V2. The two plate-circuits P1 and P2 of the respective gas-tubes V1 and V2 are connected together through a capacitor C3, which assists in firing-transfer, as explained in the Mehring patent. The two cathode-circuit loading-resistors R1 and R2 are respectively shunted by capacitors C1 and C2, which also assist in firing-transfer, as set forth in the Mehring patent. The two plate or anode-circuits P1 and P2 of the two gas-tubes are connected, through resistors R3 and R4, respectively, to a common conductor 24, which is, in turn,

connected to the positive bus (+) through a make-contact 25 of the fault-detector FD.

The grid-controlling secondaries 11 and 12 of the input-transformer IT are connected between the grid-circuits and the screen-grid circuits 26 and 27 of the respective gas-tubes V1 and V2, these two screen-grid circuits 26 and 27 being connected to different taps on the biasing-resistor RB, so that the gas-tube V1 starts firing on a slightly lower fault-current, (as supplied by the input-transformer IT), than the gas-tube V2, because the gas-tube V1 has a smaller negative biasing potential applied thereto from the biasing-resistor RB. This is the only essential difference between the illustrated phase-comparison carrier-current system and that which is shown in the Mehring patent, the illustrated cathode-circuit biasing-resistor RB being substituted for Mehring's C-battery source Ec and Mehring's two unequal voltage-dividing resistors R1 and R2.

As set forth in the Mehring patent, the voltage-drop in the cathode-resistor R2 of the second triggering gas-tube V2 is utilized, through the circuit 22, during fault-conditions (under the control of the fault-detector FD), to apply a succession of positive or operating-voltage impulses to the grid-circuit 30 of a relay-tube RT, during alternate half-cycles of the line-frequency output of the HKB network. This is done by having the cathode-circuit 22 of the gas-tube V2 connected to said relay-tube grid, through a loading-resistor R5 and a grid-circuit resistor R6.

As further explained in the Mehring patent, the voltage-drop in the cathode-resistor R1 of the first triggering gas-tube V1 is utilized, through the circuit 21, as a source of energy for the plate-circuit PC1 of the main oscillator-tube OSC-1 of a carrier-current transmitter, which thus transmits, during fault-conditions (under the control of the fault-detector FD), during the line-frequency half-cycles which have a polarity opposite to the polarity of the half-cycles during which the operating-voltage impulses are generated in the cathode-circuit 22 of the other triggering gas-tube V2.

The oscillator-tube OSC-1 is associated with a tuned circuit 31 which is tuned to a carrier-frequency f_1 , and the output of the oscillator is amplified, through two amplifier-tubes A1 and A2, and supplied to the primary winding of an output-transformer OT-1. The output-transformer OT-1 has a secondary winding 32 which is provided with a line-tap 33, a receiver-tap 34 and a grounded terminal 35.

The receiver-tap 34 leads to a tuning-capacitor TC1 and a tuned-circuit 36, both of which are tuned to the same radio-frequency f_1 as the oscillator, and thence a control-voltage is applied to the grid-circuit 37 of a receiver-tube REC-1. The output of the receiver-tube REC-1 is utilized, through a voltage-doubler 38, to apply a negative or restraining-voltage to the loading-resistor R5, thus restraining the relay-tube RT against operation, whenever carrier-current energy, of the frequency f_1 , is being received by the receiver-tube REC-1.

The output of the relay-tube RT is applied, through a relay output-transformer ROT, to the operating-coil of a relay R, which thus responds to the line-frequency component of the output-current of the relay-tube RT.

The equipment, as thus far described, is included at both ends or terminals of the protected line-section. This constitutes a phase-comparison carrier-current protective relaying-system for

quickly tripping the breakers 2, at both terminals, whenever a line-current having a fault-magnitude sufficient to pick up the fault-detectors FD is flowing in a direction into the protected line-section 1 from the terminal-buses W and E at both of the ends of the line-section, as fully explained in the Mehring patent.

In accordance with my present invention, I provide an extra transmitter at the large-capacity terminal W of the protected line-section, and an extra receiver at the limited-capacity terminal E.

The second carrier-current transmitter, at the large-capacity west station W, is diagrammatically represented by an oscillator-tube OSC-2, which is associated with two amplifier-tubes A1-2 and A2-2, and an output-transformer OT-2. This second oscillator-tube OSC-2 is of the continuously transmitting type, that is, a type which is continuously transmitting during normal fault-free conditions on the transmission-system. This is brought about by energizing the plate-circuit PC2 of the oscillator-tube OSC-2, from the positive terminal (+) of the station direct-current source, through the back-contact 40 of an auxiliary tripping-relay SG which is utilized at this west station, as will be subsequently described. The second oscillator-tube OSC-2 is associated with a tuned circuit 42 which is tuned to a second carrier-current frequency f_2 which is different from the carrier-current frequency which is used in the phase-comparison protective system, thus causing the second oscillator to transmit at this second frequency.

At the other line-terminal E, a second receiver-tube REC-2 is used, the grid-circuit of which is connected to the receiver-tap 34 of the carrier-transmitter output-transformer OT-1, at this station, through a tuning-capacitor TC2 and a tuned circuit 47, both of which are tuned to the second carrier-current frequency f_2 , that is, to the frequency of the continuous carrier-current transmitter which is located at the other line-terminal W. The output of the second receiver-tube REC-2, at the east station E, is utilized to energize the operating-coil of a carrier-receiver relay PG, which is utilized as a transfer-tripping relay.

The use of two carrier-current frequencies necessitates certain changes in the carrier-current coupling-means, which are shown in the Mehring patent, for connecting the carrier-current transmitter and receiver tubes to one of the phase-conductors of the protected line-section 1.

At the large-capacity west station W, I have shown two coupling-transformers CT-1 and CT-2, which are connected, through two-conductor coaxial cables 51 and 52, respectively, to the secondary windings of the respective carrier-current output-transformers OT-1 and OT-2. The coupling-transformer CT-1, for the first carrier-frequency f_1 , that is, for the frequency of the intermittent, or fault-started, transmitter of the phase-comparison carrier-current system, is connected to the lead-in carrier-cable 53, through an f_1 -frequency line-tuner 54 and an f_2 -frequency trap 55. The coupling-transformer CT2, for the second carrier-frequency f_2 , that is, for the frequency of the continuous carrier-current transmitter which is stopped by the auxiliary tripping-relay SG, is coupled to the carrier-current lead-in cable 53, by means of an f_2 -frequency line-tuner 56 and an f_1 -frequency trap 57. The carrier-current lead-in-cable 53 is coupled to phase-C of the line 1, through a coupling-transformer 58,

and it is connected to ground through a choke-coil 59.

By separating the two carrier-current frequencies f_1 and f_2 by approximately ten to thirty percent, it is possible to adequately segregate the frequencies by the above-described line-tuners and traps, and at the same time, it is generally possible to utilize a broadly tuned line-trap 60 at both terminals of the protected line-section 1, although double frequency line-traps may be necessary or desirable in some applications; and it is also possible, at the limited-capacity station E, to utilize a single coupling-transformer CT—1—2, which is connected to the carrier-current lead-in cable 53, at this station, through a line-tuner 61, which is tuned broadly enough to include both of the carrier-current frequencies f_1 and f_2 . The coupling-transformer CT—1—2 is connected to the secondary winding of the carrier-current output-transformer OT—1, at this limited-capacity station E, through a two-conductor coaxial cable 62.

In addition to the above-described equipments, which are connected to the protected line-section at the respective terminals thereof, the limited-capacity east station E is provided with a bank of potential-transformers 63, which are utilized to energize the operating-coils of three undervoltage fault-detector relays VA, VB and VC, for the three delta line-phases. These undervoltage relays serve as fault-detectors by responding to a predetermined drop in the line-voltage. They are intended, in the broader aspects of my invention, to be representative of any fault-detector which does not require a magnitude of line-current which is necessary to pick up the current-responsive fault-detector FD at this station E.

The direct-current tripping and reclosing circuits, for controlling the circuit-breakers 2 at the respective ends of the protected line-section 1, are shown at the bottom of the drawing. The basic tripping and reclosing circuits are identical, at both ends of the line, with certain additional equipment added at the limited-capacity end E, for providing the quick tripping which is necessary, at this station, in order to clear an arcing-fault on the protected line-section, so that the breakers at both ends can be reclosed, even though the fault-current at low-capacity end E may be insignificant. I will first describe the basic tripping and reclosing circuit, which is common to both ends of the protected line-section.

The fault-detector FD has a make-contact 64 which is connected to the negative station-bus (—) in series with the make-contact R of the phase-comparison relay R, to energize the circuit 65 of the operating-coil SX of a reclosing-relay SX, which is preferably a relay of the position-retaining type. The operating-coil SX is connected, through a conductor 66, to the operating-coil of the auxiliary tripping-relay SG, which has previously been mentioned in connection with the control of the second carrier-current oscillator OSC—2 at the station W. The operating-coil SG is connected, through a circuit 67, to an auxiliary make-switch a of the circuit-breaker 2 at the relaying-station, and thence to the positive station-bus (+). The trip-coil TC, of the breaker at this station, is energized by a parallel circuit extending between the conductors 66 and 67, and serially including a make-contact 68 of the auxiliary tripping-relay SG. Any desired additional tripping-circuits may also be provided, as are symbolically represented by a back-up make-contact BU, which is connected

between the negative-terminal (—) and the conductor 66, thus providing back-up tripping, without an accompanying reclosing-operation, because the reclosing-relay SX is not energized by the back-up contact BU.

Any suitable reclosing circuit or control-system may be utilized. An illustrative reclosing system is shown, in its simplest elements, as comprising a make-contact SX of the reclosing relay, this make-contact SX being connected to the negative bus (—), in series with a manually controllable switch 70, an auxiliary breaker-contact bb , which closes at an early stage during the opening movement of the breaker-mechanism, and a back-contact TR of a toggle-relay or other position-retaining relay TR, and thence to a conductor 71.

The conductor 71 is utilized to energize the operating-coil X of a closing-relay X, the circuit of which also includes the back-contact Y of a releasing-relay Y. The back-contacts Y are a little slow in opening, in response to an energization of said releasing-relay Y, as is diagrammatically indicated by means of a dashpot 72.

If the reclosing-relay SX is of the position-retaining type, as has been assumed in the illustrated form of embodiment of my invention, it is provided with a reset-coil SX_r , which is energized from the conductor 71 in series with a make-contact X of the closing-relay X.

The conductor 71 is also utilized to energize the operating-coil Y of the releasing-relay Y, the circuit of which is completed through an auxiliary breaker-switch aa , which opens at an early stage during the opening-movement of the breaker-mechanism. The time-relay, which is introduced by the dashpot 72, or other delaying-means, on the releasing-relay Y, is sufficient to prevent the possibility of the opening of the releasing-relay back-contact Y prior to the opening of the auxiliary breaker-switch contacts aa . These switch-contacts aa are bypassed by a make-contact Y of the releasing-relay Y.

The next line of the schematic direct-current diagram shows a holding-circuit 74 for the conductor 71, this holding-circuit 74 including a closing-relay make-contact X, which connects the circuit 71 to the negative bus (—). This line of the schematic diagram also shows the utilization of the conductor 71 to energize a closing-coil circuit 75 in series with another make-contact X of the closing-relay X. The circuit 75 energizes the closing-coil CC of the breaker at this station, and also a parallel-connected operating-coil TR of the toggle-relay TR.

The toggle-relay TR has a make-contact TR which energizes an alternating-current line-frequency circuit, which is shown inset into the direct-current diagram of the drawing, to energize the winding T of a reclosing-relay timer T, in series with a circuit-breaker make-contact a , in a sixty-cycle timer-circuit marked AC—AC. The timer T has a make-contact T which energizes the reset-coil TR_r of the toggle-relay TR.

At the east station E, the breaker-tripping and reclosing circuits are the same as have just been described, with the addition of a transfer-tripping circuit 80 for providing another means for energizing the circuit 65 of the auxiliary reclosing-relay SX. The transfer-tripping circuit 80 operates under the control of a back-contact PG of the previously mentioned transfer-tripping relay PG, under the supervision or control of a serially connected, manually controllable switch 81. Preferably also, as shown, the back-contact

PG of the transfer-tripping relay PG is supervised by the fault-detectors VA, VB and VC at the station E, so that a transfer-tripping operation will not be effected, at the station E, unless there is some indication of the existence of a fault, as determined by the undervoltage fault-detectors VA, VB and VC. These undervoltage fault-detectors have back-contacts VA, VB and VC, which are connected in parallel with each other, and in series with the make-contact PG in the transfer-tripping circuit 80.

In operation, if there is an internal fault within the protected line-section I, which draws a sufficient fault-current, from the limited-capacity bus E, to pick up the fault-detector FD at the station E, an instantaneous or quick tripping-operation is obtained as a result of the energization of the circuit 65 from the fault-detector contact 64 and the make-contact R at both terminals of the phase-comparison carrier-current protective system, substantially as shown and described in the Mehring patent. This operation occurs at both ends of the protected line-section.

If there is an internal fault, within the protected line-section I, which does not draw a sufficient fault-current, at the limited-capacity station E, to pick up the fault-detector FD at said station E, then an instantaneous tripping-operation will be obtained at the large-capacity station W, for lack of a restraining-voltage which does not come, from carrier transmitted at the station E, during the line-frequency half-cycles when the operating-voltage of the conductor 22 is applied to the relay-tube RT at the station W. The phase-comparison relay R, at the station W, thus picks up and energizes the conductor 65 of the tripping-circuit at the station W. A corresponding phase-comparison tripping-operation does not occur at the limited-capacity station E, because the non-response of the fault-detector FD at this station holds the two triggering gas-tubes V1 and V2 inactive, thus preventing the development of an operating-voltage for the relay-tube RT at this station, as well as preventing the transmission of carrier at this station.

As a result of the assumed internal fault, however, one or more of the undervoltage relay-contacts VA, VB or VC will close, at the station E, and within about a line-frequency cycle of the same time, the receipt of the continuously transmitted f_2 -frequency carrier, at the station E, will be stopped, either as a result of the interruption of carrier-current transmission through the phase-conductor C, by a fault on said conductor, or as a result of the energization of the auxiliary tripping-relay SG, at the large-capacity station W, which opens the SG back-contact 40 in the energizing circuit of the f_2 -frequency transmitter at the station W. In either event, the f_2 -frequency carrier-receiver relay PG, at the limited-capacity station E, is deenergized, thus closing its back-contact PG in the transfer-tripping circuit 80, which effects a tripping-operation of the breaker at the limited-capacity station E, within one or two line-frequency cycles after the tripping-operation at the large-capacity station W.

In the case of an external fault, that is, a fault on or beyond either one of the terminal-buses W or E, outside of the protected line-section I, no instantaneous or quick tripping-operation is obtained, and any tripping which is done must be brought about by whatever back-up relays BU are provided.

Thus, for faults external to the large-capacity station W, any fault-current which appears in

the protected line-section I must come from the limited-capacity station E. If this fault-current is too small to pick up the fault-detectors at the two ends of the line-section, there will be no energization of the triggering gas-tubes V1 and V2, at either end of the line-section, and hence there will be no operating-voltage applied to the relay-tube RT, and hence no instantaneous phase-comparison tripping, at either end of the protected line-section I. If, however, the fault-current, which is transmitted over the protected line-section from the low-capacity station E to the faulted large-capacity station W, is sufficient to pick up the fault-detectors FD at the two ends of the protected line-section, then f_1 -frequency phase-comparison carrier-current impulses will be transmitted from both ends of the protected line-section, thus producing carrier-received restraining-impulses which coincide with the half-cycle operating-voltage impulses of the transfer-tripping system at each end of the protected line-section, thus blocking tripping in the conventional manner, as for any through-current fault in a line-section which is protected by the phase-comparison protective system of the Mehring patent.

If the external fault is external to the limited-capacity station E, then the fault-current which appears in the protected line-section I is supplied by the large-capacity station W, and this fault-current is always large enough to pick up the fault-detectors FD at both ends of the protected line-section, thus blocking tripping, as in any phase-comparison protective system, such as is disclosed in the Mehring patent.

While I have illustrated my invention in but a single preferred or suggestive form of embodiment, and while I have suggested several places in which equivalents could be substituted, I do not wish to be limited to these particularly mentioned equivalent-substitutions, and I wish it to be understood, also, that my illustrated system is much simplified, in the interests of avoiding unnecessary confusion of the diagram. It should be understood, therefore, that various changes may be made, by those skilled in the art, by way of omissions, additions and substitutions, without departing from the broader aspects of my invention, and I desire that the appended claims shall be accorded the broadest construction consistent with their language.

I claim as my invention:

1. A protective carrier-current relaying-system for protecting a line-section of a transmission-system against internal faults within said line-section, comprising fault-responsive relaying-means, at a first terminal of the protected line-section, for reliably determining the existence of an internal fault within the protected line-section, a normally continuously transmitting carrier-current transmitting-means, at said first terminal, for transmitting, to a second terminal of the protected line-section, during normal fault-free operating-conditions within the protected line-section, a continuous distinctive carrier-current signal denoting the continuance of a fault-free condition within the protected line-section, as determined at said first terminal, means disposed at said first terminal for stopping the transmission of said distinctive continuous carrier-current signal in response to a response of said fault-responsive relaying-means at said first terminal, and means disposed at said second terminal for providing at internal-fault response to a non-receipt of said distinctive

continuous carrier-current signal from the first terminal.

2. A quick-reclosing carrier-current protective-system for protecting a transmission-line section which extends between a first electrical bus and a second electrical bus, said first electrical bus being disposed at a first terminal of the protected line-section and having sufficient fault-current-supplying capacity for reliable instantaneous fault-determination at said first terminal, said second electrical bus being disposed at a second terminal of the protected line-section and, at least at times, having insufficient fault-current-supplying capacity for reliable instantaneous fault-determination at said second terminal, said quick-reclosing protective system comprising an instantaneous fault-responsive protective-means, at each of said terminals, for responding to an internal fault within the protected line-section and for effecting a quick interrupter-opening operation for disconnecting the protected line-section from the bus at the terminal where the fault-responsive relaying-means is located, and a reclosing-means, at each of said terminals, for responding to a quick interrupter-opening operation at the terminal where the reclosing-means is located and for promptly effecting an automatic interrupter-reclosing operation for reconnecting the protected line-section to the bus at the terminal where the reclosing-means is located, said protective-system being characterized by further comprising a normally continuously transmitting carrier-current transmitting-means, at said first terminal, for transmitting, to said second terminal, during normal fault-free operating-conditions within the protected line-section, a continuous distinctive carrier-current signal denoting the continuance of a fault-free condition within the protected line-section, as determined at said first terminal, means disposed at said first terminal for stopping the transmission of said distinctive continuous carrier-current signal in response to a response of said fault-responsive protective-means at said first terminal, and means disposed at said second terminal for effecting a quick interrupter-opening operation for disconnecting the protected line-section from the bus at said second terminal in response to a non-receipt of said distinctive continuous carrier-current signal from the first terminal.

3. A protective carrier-current relaying-system for protecting a transmission-line section which extends between a first electrical bus and a second electrical bus, said first electrical bus being disposed at a first terminal of the protected line-section and having sufficient fault-current-supplying capacity for reliable instantaneous fault-determination at said first terminal, said second electrical bus being disposed at a second terminal of the protected line-section and, at least at times, having insufficient fault-current-supplying capacity for reliable instantaneous fault-determination at said second terminal, said relaying-system comprising an instantaneous fault-responsive protective-means, at each of said terminals, for responding to an internal fault within the protected line-section, each of said fault-responsive protective-means including a carrier-responsive blocking-means for blocking an instantaneous fault-response of said fault-responsive protective-means, a normally non-transmitting carrier-current transmitting-means, at each of said terminals, for at times transmitting a carrier-current signal for energizing the

carrier-responsive blocking-means at the other terminal, a fault-responsive carrier-starting means, at each of said terminals, for starting the normally non-transmitting carrier-current transmitting-means at the terminal where the fault-responsive carrier-starting means is located, a normally continuously transmitting carrier-current transmitting-means, at said first terminal, for transmitting, to said second terminal, during normal fault-free operating-conditions within the protected line-section, a continuous distinctive carrier-current signal denoting the continuance of a fault-free condition within the protected line-section, as determined at said first terminal, means disposed at said first terminal for stopping the transmission of said distinctive continuous carrier-current signal in response to a response of said fault-responsive protective-means at said first terminal, and means disposed at said second terminal for effecting a quick internal-fault response in response to a non-receipt of said distinctive continuous carrier-current signal from the first terminal.

4. A quick-reclosing carrier-current protective-system for protecting a transmission-line section which extends between a first electrical bus and a second electrical bus, said first electrical bus being disposed at a first terminal of the protected line-section and having sufficient fault-current-supplying capacity for reliable instantaneous fault-determination at said first terminal, said second electrical bus being disposed at a second terminal of the protected line-section and, at least at times, having insufficient fault-current-supplying capacity for reliable instantaneous fault-determination at said second terminal, said quick-reclosing protective system comprising an instantaneous fault-responsive protective-means, at each of said terminals, for responding to an internal fault within the protected line-section and for effecting a quick interrupter-opening operation for disconnecting the protected line-section from the bus at the terminal where the fault-responsive relaying-means is located, each of said fault-responsive protective-means including a carrier-responsive blocking-means for blocking an instantaneous fault-response of said fault-responsive protective-means, a normally non-transmitting carrier-current transmitting-means, at each of said terminals, for at times transmitting a carrier-current signal for energizing the carrier-responsive blocking-means at the other terminal, a fault-responsive carrier-starting means, at each of said terminals, for starting the normally non-transmitting carrier-current transmitting-means at the terminal where the fault-responsive carrier-starting means is located, and a reclosing-means, at each of said terminals, for responding to a quick interrupter-opening operation at the terminal where the reclosing-means is located and for promptly effecting an automatic interrupter-reclosing operation for reconnecting the protected line-section to the bus at the terminal where the reclosing-means is located, said protective-system being characterized by further comprising a normally continuously transmitting carrier-current transmitting-means, at said first terminal, for transmitting, to said second terminal, during normal fault-free operating-conditions within the protected line-section, a continuous distinctive carrier-current signal denoting the continuance of a fault-free condition within the protected line-section, as deter-

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mined at said first terminal, means disposed at said first terminal for stopping the transmission of said distinctive continuous carrier-current signal in response to a response of said fault-responsive protective-means at said first terminal, and means disposed at said second terminal for effecting a quick interrupter-opening operation for disconnecting the protected line-section from the bus at said second terminal in response to a non-receipt of said distinctive continuous carrier-current signal from the first terminal.

5. The invention as defined in claim 1, in combination with fault-detector supervisor-means, at the second terminal, for supervising the response to a non-receipt of said distinctive continuous carrier-current signal at said second terminal.

6. The invention as defined in claim 2, in combination with fault-detector supervisor-means, at the second terminal, for supervising the response to a non-receipt of said distinctive continuous carrier-current signal at said second terminal.

7. The invention as defined in claim 3, in combination with fault-detector supervisor-means, at

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the second terminal, for supervising the response to a non-receipt of said distinctive continuous carrier-current signal at said second terminal.

8. The invention as defined in claim 4, in combination with fault-detector supervisor-means at the second terminal, for supervising the response to a non-receipt of said distinctive continuous carrier-current signal at said second terminal.

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