This invention relates to indicating means, and more particularly to indicating means having inherent characteristics protecting it against giving a false indication due to a cross, a ground or the application of either direct or alternating current from a foreign or unauthorized source.

Indication apparatus having the characteristics above mentioned is more particularly applicable to railway signalling, interlocking and automatic train control practice, but also may be used in any other relation where it is absolutely necessary to give an indication which can be relied upon. In accordance with the embodiment of the invention illustrated, it is proposed to indicate in a local tower of a railway system the position of a distant track switch, the source of energy for transmitting such indication being preferably located in the tower, and the indication position being determined by the position of contacts at such distant track switches, these contacts forming part of the usual switch box associated with track switches in common use.

More specifically, it is proposed, to use two branch circuits in the tower connected in series with a source of alternating current, and connected in series with a rectifier located at the distant track switch, this rectifier being poled in the circuit in a direction depending upon the position of the track switch. In the specific embodiment of the invention shown, the branch circuits in the dispatcher's office include the two windings of a polyphase induction type relay. From the foregoing it appears that in addition to the feature of giving an indication in the tower in a safe way, another object resides in the feature that no source of current is necessary at the distant track switch to give the desired information.

Other objects, purposes and characteristic features of the present invention will appear in part as the description thereof progresses, and will in part be apparent from the accompanying drawing.

In describing the invention in detail reference will be made to the single drawing, in which the apparatus shown in the dotted rectangle is the apparatus located in the tower, and the remaining apparatus is that located at a distant track switch of a railway system.

Referring to the drawing the main track of the railway system has been illustrated by rails 1, whereas the siding has been illustrated by rails 2, this siding connecting with the main track through the medium of a switch S. The switch S is connected by the usual indicating rod 3 to a switch box including pole changing contacts 4 and 5 adapted to engage stationary contacts 6, 7, and 8. These pole changing contacts connect the rectifier R to the indicating line wires 10 and 11, in a polar or rectifying direction depending on the position of the switch S and the switch box contacts 4 and 5. It may be pointed out here that the rectifier R is preferably one of either the electrolytic, crystal or copper oxide type in which the direction of rectification is inherent in the device in accordance with chemical action or physical phenomena inherent in its structure. Also, the rectifier is preferably one that allows a certain amount of leakage or back flow of current therethrough for reasons pointed out hereinafter. Although a rectifier of the thermal or Fleming valve type may be used, a rectifier of this latter type is less desirable especially if the thermal electrode thereof requires external heating.

In the local tower, designated by the dotted rectangle R, are located indicating lamps RI and NI, designating respectively that the distant track switch S is in the reverse take-siding and the normal straight track position. One of the lamps RI or NI may be illuminated depending upon the position of the contact 14 of the indicating relay IR. This indicating relay IR is a relay of the alternating current inductive type, in which the conductive rotor 15 constitute a disc or cup of suitable conducting material such as aluminum, this rotor 15 being located in a shifting magnetic field produced by the windings 16 and 17, providing both of these windings 16 and 17 are carrying an alternating or pulsating current, and that these currents are displaced in phase.

The windings 16 and 17 are constructed substantially alike and have the same impedance and ohmic resistance, and are
mounted on a magnetic structure such as used in polyphase induction relays of this type, an example of which is illustrated in the prior patent to Howe 1,710,664 dated April 23, 1929.

The windings 16 and 17 of the indicating relay IR are connected in multiple and across the indicating line 10—11, this indicating line 10—11 having the secondary winding of a transformer 18 connected in series therewith. The primary winding of this transformer is constantly supplied with alternating current of a suitable frequency either constant or variable, and these windings 16 and 17 have connected in series therewith the rectifiers 20 and 21, respectively. These rectifiers have their valve action polarized in opposite directions in the two multiple paths through windings 16 and 17.

Operation.—Under normal conditions, that is, with the track switch in the normal main track position, the switch box contacts 4 and 5 are so positioned that a pulsating direct current of comparatively large value will flow through the following circuit: beginning at the secondary winding of the transformer 18, wire 11, contacts 5—7, wire 23, rectifier R, wires 24 and 25, contacts 6—4, line wire 10, wire 26, rectifier 21, relay winding 17, wire 11, back to the secondary winding of transformer 18. It will be noted that the circuit just traced has the rectifiers R and 21 connected in series therein in a manner so that the valve action of these rectifiers is in the same direction in the circuit, so that a uni-directional pulsating current of appreciable value can flow in the circuit just traced. Also, it will be noted that the resistance of the circuit just traced insofar as the flow of this pulsating current is concerned is rather high, so that the pulsating current will lag appreciably behind the voltage impressed upon said circuit by reason of the inductance of the winding 17 of relay IR.

There is, however, another circuit present in which current may flow, which may be traced as follows: beginning at the secondary winding of the transformer 18, wire 11, contacts 5—7, wire 23, rectifier R, wires 24 and 25, contacts 6—4, wires 10 and 27, rectifier 20, winding 16, and wire 11, back to the secondary winding of transformer 18. It will be noted that in the circuit just traced, the rectifier R and 20 are so arranged in this circuit that their valve actions oppose each other, so that the rectifiers R and 20 act upon the circuit exactly the same as a comparatively high resistance. From this it appears that there will be an alternating current flowing in the winding 16 of the relay IR, which current is considerably smaller in value than the current flowing in winding 17 by reason of a high resistance of the circuit, and this high resistance makes this alternating current flow substantially in phase with the voltage of the secondary winding of transformer 18. From the foregoing it is apparent that with two currents displaced in phase flowing in the two windings of the polyphase induction type relay, a torque will be produced in the rotor of such relay which torque is assumed to be in a direction to move the contact 14 to the right-hand position.

Also, it is readily apparent that if the track switch S is moved to the take-siding position, thereby moving the switch box contact 4 and 5 to the dotted position, the rectifier R has its valve action pole changed, so that the rectifier R is poled in the same direction with the rectifier 20, but is poled oppositely with respect to the rectifier 21. In other words, with the track switch S moved to the take-siding position the character of current flow in the windings 16 and 17 of the relay IR is reversed, so that the direction of torque produced in the rotor 15 is reversed, and the contact 14 will assume the left hand extreme position, and the lamp RL is illuminated. Let us now study and observe the characteristics of cross protection afforded by the present invention, and why the unauthorized application of either direct or alternating current to the line wires 10 and 11, and certain other failures that can occur will not cause the indicating relay IR to move to its extreme right hand or its extreme left hand position, accidentally.

Let us first assume that a cross occurs between the wires 10 and 11. If such cross were to occur, the characteristic of current flow in the windings 16 and 17 would be identical, that is, pulsating alternating current would be flowing in both of these windings. By pulsating alternating current is meant alternating current with half of each cycle of larger amplitude than the other half. This large amplitude alternates from one winding to the other in the relay IR, but since the half cycles react in opposition the resulting torque is zero.

Let us now assume that a cross occurs between the wires 10 and 11, but no false indication could possibly be given by the indicating relay IR under these conditions, because both windings 16 and 17 of the relay IR would be short-circuited.

Let us now assume that an alternating current is applied between the wires 10 and 11, no false indications could be given under these circumstances because the effect produced would be the same as with the line wires 10 and 11 short-circuited, as already considered. Similarly, the application of direct current to the wires 10 and 11 would not produce a torque in an induction type relay for obvious reasons.

Let us now assume that the rectifier R becomes open-circuited, obviously no false indication could be given by open circuiting of
rectifier R, because no current could flow to the indicating relay IR.

Let us now assume that either wire 26 or 27 is broken, in each case there would be current flow in one of the windings 16 or 17 of the relay IR only, and no torque can be produced in an induction relay with only one of its windings energized.

It is to be noted also, that variations in frequency of the alternating current which may occur in practice due to speed variations of the prime mover driving the alternating current generator, have no effect on the system, and do not in any way detract from its reliability, because the principle of operation of rectifying valves does not depend on frequency. In fact the indicating system shown and described operates with the employment of any frequency below the frequencies known as radio frequencies.

Applicant has thus shown and described a rather unique indicating system in which the indication is carried over a single line circuit requiring the pole changing of a rectifier located at the distant point from which the indication is to be transmitted, all in a manner so that no false indication can possibly be transmitted from the distant station to the local tower 12. In this connection it may be pointed out that separate alternating current relays may be used in the circuit arrangement shown in place of the windings 16 and 17 respectively of the indicating relay IR. There are however certain shortcomings in this arrangement, in that if one of these relays should become open-circuited the other relay might possibly be energized falsely, at least by a current of small value, thus making the arrangement impracticable and unreliable for railway signalling, automatic train control, and interlocking purposes.

Having thus shown and described one preferred embodiment of the present invention, and having illustrated this embodiment rather conventionally, it is desired to be understood that the simplified showing adopted has been selected for the purpose of facilitating description of the invention, and have not been selected with the intent of showing the scope of the invention or the preferred construction preferably employed in practicing the same, and that various changes, modifications and additions may be made to adapt the invention to the particular use to which the invention is desired to be put, all without departing from the spirit or scope of the invention, or the idea of means underlying the same, except as demanded by the scope of the following claims:

What I claim as new is:

1. Indicating means comprising; a local station; a distant station; local indicating means; distant control means; and means for operating said indicating means by said control means comprising, a polyphase induction relay having two windings connected in multiple and included in series with a source of alternating current, rectifying means in series with one of said windings permitting ready flow of pulsating current in one direction from said source, rectifying means in series with said other winding permitting ready flow of pulsating current in the opposite direction from said source, and a third rectifier located at said distant station included in a closed circuit including said source and said relay.

2. Indicating apparatus comprising, a circuit connecting a local and a distant point, a source of alternating current in said circuit, indicating means in said circuit at said local point responsive only if two kinds of current flow therethrough, and means at said distant point for causing the flow of two kinds of currents from said source through said indicating means.

3. Indicating apparatus comprising, a circuit connecting a local and a distant point, a source of alternating current in said circuit, indicating means in said circuit at said local point responsive only if a rectifier permitting the free flow of current in one direction and permitting a restricted flow of current in the other direction is included in said circuit, and a rectifier permitting such flow of current located at said distant point and at times included in said circuit.

4. Indicating apparatus comprising, a circuit connecting a local and a distant point, a source of alternating current in said circuit, indicating means in said circuit at said local point consisting of a polyphase induction relay having its two windings connected in multiple, each winding having a rectifier in series therewith permitting the free flow of current in one direction and a restricted flow of current in the other direction, said rectifiers having their valve actions directed oppositely in said circuit, and another rectifier at said distant point at times included in said circuit.

5. Indicating apparatus comprising, a circuit connecting a local and a distant point, a source of alternating current in said circuit, indicating means in said circuit at said local point consisting of a polyphase induction relay having its two windings connected in multiple, each winding having a rectifier in series therewith permitting the free flow of current in one direction and a restricted flow of current in the other direction, said rectifiers having their valve actions directed oppositely in said circuit, and another rectifier at said distant point at times polarized in one direction in said circuit and at times polarized in the other direction in said circuit, whereby said relay will assume a particular energized position depending on the polarity arrangement of said another rectifier in said circuit.
6. Indicating means comprising; a local station; a distant station; local indicating means; distant control means; and means for operating said indicating means by said control means comprising, a polyphase induction relay having two windings connected in multiple and included in series with a source of alternating current, rectifying means in series with one of said windings permitting ready flow of pulsating current in one direction from said source, rectifying means in series with said other winding permitting ready flow of pulsating currents in the opposite direction from said source, and a third rectifier located at said distant station included in a closed circuit including said source and said relay, and at times poled in one direction and at times poled in the other direction in said circuit.

7. Indicating apparatus comprising, a circuit connecting a local and a distant point, a source of alternating current in said circuit, indicating means in said circuit at said local point responsive only if a rectifier permitting a restricted flow of current in one direction is included in said circuit, and a rectifier permitting such flow of current and located at said distant point at times included in said circuit.

8. An electro-responsive device responsive to pulsating uni-directional current but not responsive to either continuous direct current or alternating current comprising, electro-magnetic means and rectifying means connected to permit response of said electro-responsive means only in the event pulsating current is applied thereto.

9. An electro-responsive device responsive to pulsating uni-directional current but not responsive to alternating current comprising, electro-magnetic means and rectifying means connected to permit response of said electro-responsive means only in the event pulsating current is applied thereto.

10. An electro-responsive device responsive to pulsating uni-directional current but not responsive to continuous direct current comprising, electro-magnetic means and rectifying means connected to permit response of said electro-responsive means only in the event pulsating current is applied thereto.

11. Indicating apparatus comprising, a source of alternating current, a circuit including said source, a rectifier, and indicating means in said circuit responsive to said source to give one distinct indication only if said rectifier is included in series, therewith to rectify current in one direction and to give another distinct indication only if said rectifier is included in series therewith to rectify current in another direction.

12. In an electrical system of control, the polyphase induction type relay having two field windings, a rectifier in series with each winding permitting free flow of uni-directional current in that winding in one direction and a restricted flow of current in the opposite direction, said rectifiers being arranged to permit such free flow of current in said windings in opposite directions, and means for supplying uni-directional pulsating voltage to said relay, said means being controllable to reverse the polarity of said voltage.

13. In an electrical system of control, a relay of the polyphase induction type, a rectifier in series with each winding of said relay having high resistance back-leak characteristics, said rectifiers being arranged to allow free flow of current in said windings in opposite directions, an energizing circuit for said relay including a source of alternating current, and pole changing means for including another rectifier in said circuit in one polarity sense or the other.

14. In an electrical system for transmitting any one of three different conditions over two wires, a three-position alternating current relay of the polyphase induction type, rectifying means associated with the two windings of said relay for causing said relay to assume one operated position or the other in accordance with the polarity of uni-directional voltage applied thereto, and means including a rectifier and a pole changing device for supplying such uni-directional voltage of one or the other polarity to said relay over said two wires.

15. In an electrical system of communication, a three-position alternating current relay of the polyphase induction type, a rectifier in series with each winding of said relay, an energizing circuit for said relay including a source of alternating current, another rectifier, and pole changing means for including said another rectifier in said circuit in one polarity sense or the other.

16. In a system for indicating the position of the points of a track switch, an alternating current relay of the polyphase induction type, oppositely poled rectifiers including in series with the windings of said relay, a circuit including a source of alternating current for supplying voltage to said windings in multiple, another rectifier, and pole changing means connected to said switch points for including said another rectifier in said circuit in one polarity sense or the other in accordance with the position of said switch points.

In testimony whereof I affix my signature.

THEODORE BODDE.