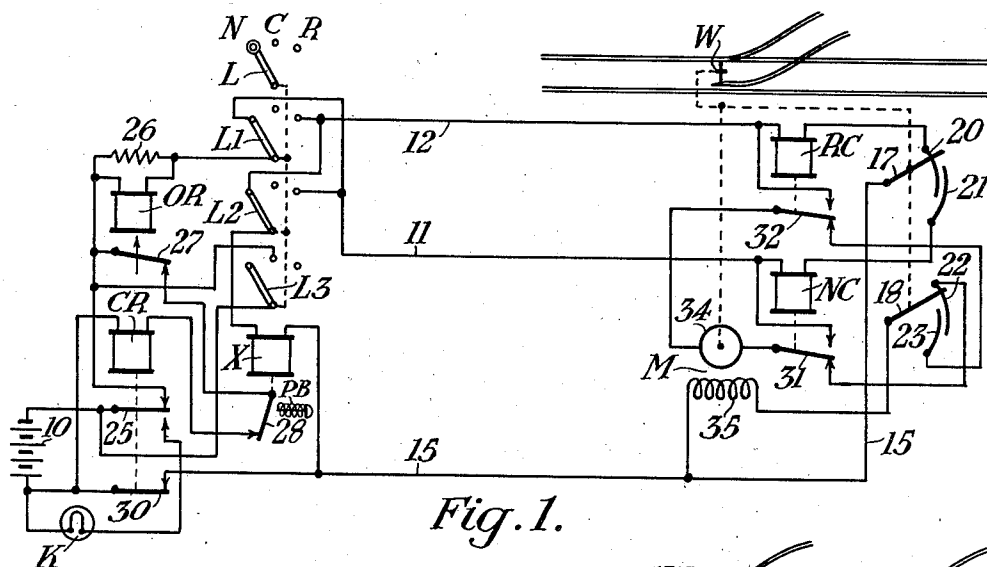
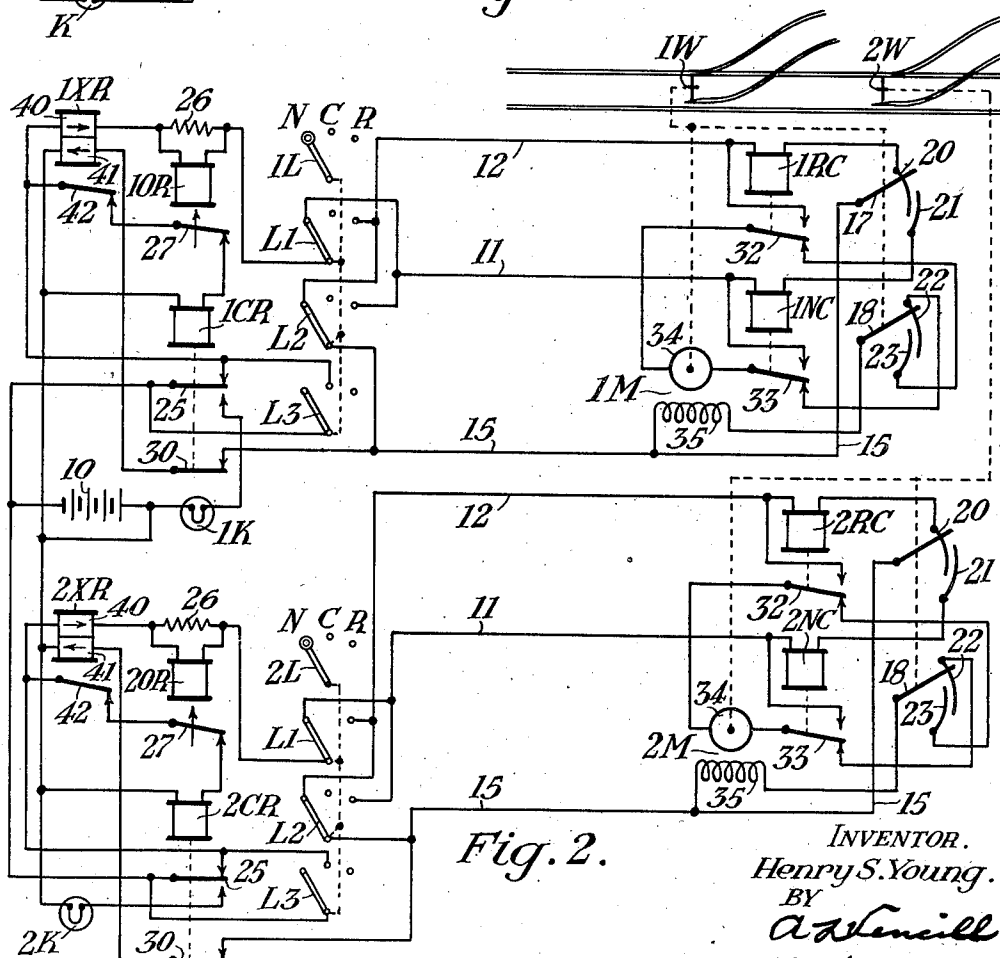


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ELECTRICAL CONTROL SYSTEM

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ELECTRICAL CONTROL SYSTEM

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My invention relates to electrical control systems such, for example, as systems for the control of railway track switches and is particularly directed to improved means for interrupting the supply of energy to the switch motor or other electrical load in the event of an overload or a defect in the control circuits.

In some types of switch control systems the switch motor is controlled from a remote point, such as an interlocking tower, by current supplied from a source at the control point over suitable control wires to control relays, while energy is also supplied from this source over the control wires to the switch motor to operate the motor.

It is an object of this invention to provide improved means for use in a system of this type to interrupt the supply of energy to the switch motor in the event that the motor draws abnormal current for an excessive period.

Another object of the invention is to provide an improved system of the type described and arranged to employ an overload relay of standard design.

A further object of the invention is to provide improved means for detecting defects in the control wires employed in systems of the type described.

Another object of the invention is to provide in a system of the type described improved cross detecting means which will detect crosses between wires associated with different switches as well as between wires associated with the same switch.

A further object of the invention is to provide an improved switch control system.

I shall describe two forms of apparatus embodying my invention, and shall then point out the novel features thereof in the claim.

In practicing my invention I employ a normally energized stick relay to control the supply of energy from a source to the control wires over which energy is supplied to the control relays and to the motor for a switch, while I employ an overload relay of standard design to detect abnormal flow of current in these wires, and, in such an event, to interrupt the circuit of the stick relay. In addition, a contact of a cross detecting relay is included in the circuit of the stick relay, while a pick-up circuit for the stick relay is established on movement of the switch control lever to its intermediate position.

In one form of the invention the cross detecting relay is provided with two opposing windings one of which is connected in series with

the wire leading from one terminal of the source and the other of which is connected in series with the wire leading from the other terminal of the source. Normally these windings are equally energized and offset each other so that the relay contact remains released, but if a defect develops, the windings will not be equally energized and the relay contact will pick up and interrupt the circuit of the stick relay to prevent supply of energy from the source.

In the drawing,

Fig. 1 is a diagram of a switch control system embodying my invention, and

Fig. 2 is a diagram illustrating a modified form of Fig. 1, also embodying my invention.

Similar reference characters refer to similar parts in both views.

Referring to Fig. 1 of the drawing, there is shown therein a railway track switch W which is moved between a normal and a reverse position by means of an electric motor M. The motor drives the switch through a suitable mechanism, not shown.

The switch W is controlled by a switch control lever L which may be located at any suitable control point; this lever may form part of an interlocking machine. The lever L is movable between a normal position N, and a reverse position R, and controls connection from one terminal of a source of current, such as a battery 10, to a normal wire 11 and a reverse wire 12, while the other terminal of the battery is connected to a common wire 15.

The lever L has associated therewith an overload relay OR, a normally energized stick relay CR, a polarized cross detecting relay X, and a lamp K. Relay X is of the well-known type in which the polar contact 28, when once closed by the push button PB, remains closed thereafter even though the relay is deenergized, and opens when energy of reverse polarity is applied to the winding. When opened, contact 28 will remain in its open position until it is reset by operation of the push button PB.

The switch W has associated therewith a normal control relay NC and a reverse control relay RC which are energized by current supplied over the normal and reverse wires 11 and 12, respectively, and which control the supply of energy over these wires to the motor M.

In addition, the switch W has associated therewith contacts 17 and 18 which are operated in accordance with movement of the switch. The contact 17 controls the circuits of the relays NC and RC and is arranged so that it engages a

stationary contact 20 in all positions of the switch except its reverse position, and engages a contact 21 in all positions of the switch except the normal position thereof. The contact 18 controls the circuit of the switch motor and is arranged so that it engages a contact 22 in all positions of the switch except the reverse position thereof and engages a contact 23 in all positions of the switch except the normal position thereof.

The equipment is shown in the condition which it assumes when the control lever L and the switch W are in their normal positions. As the lever L is in its normal position, its contact L1 establishes connection from the positive terminal of the battery 10 to normal wire 11. This connection includes in series therewith front contact 25 of relay CR, and thermal resistance 26 and winding of relay OR in multiple. At this time the relay CR is energized by current supplied over its stick circuit which is traced from the positive terminal of the battery through front contact 25 of relay CR, back contact 27 of relay OR, normal polar contact 28 of relay X, and winding of relay CR to the negative terminal of the battery.

As the relay CR is energized, its contact 30 is picked up and establishes connection from the negative terminal of the battery to common wire 15, while its contact 25 interrupts the circuit of the indication lamp K.

As the lever L is in its normal position, contact L2 connects one terminal of the winding of relay X to reverse wire 12, but at this time wire 12 is not connected to a source of current so the polar contact 28 of relay X remains in its closed position.

As the switch W is in its normal position, contact 17 is out of engagement with contact 21 and thus interrupts the circuit of the relay NC so that its contact 31 is released and interrupts connection from wire 11 to the switch motor M. The motor, therefore, is deenergized at this time.

If the operator wishes to move the switch W to its reverse position, he may do so by moving the lever L to its reverse position. On movement of the lever L to its reverse position, contact L1 interrupts connection from the positive terminal of the battery to normal wire 11 and connects it to reverse wire 12, while contact L2 interrupts connection of one terminal of the winding of relay X with wire 12 and connects it to wire 11.

When connection is established from the battery to reverse wire 12, the reverse control relay RC is energized over the circuit which is traced from wire 12 through winding of relay RC, contacts 20 and 17, common wire 15, and front contact 30 of relay CR to the negative terminal of the battery 10. Accordingly, contact 32 of relay RC picks up and establishes the circuit to energize the motor M to cause it to move the switch W to its reverse position. The circuit for energizing the motor is traced from the positive terminal of the battery 10 through front contact 25 of relay CR, thermal resistance 26 and winding of relay OR in multiple, contact L1 in its reverse position, reverse wire 12, front contact 32 of relay RC, motor armature 34, back contact 31 of relay NC, contacts 22 and 18, motor field winding 35, common wire 15, and front contact 30 of relay CR to the negative terminal of the battery. The motor, therefore, operates to move the switch W to its reverse position, and when the switch reaches its reverse position, contact 18 is moved out of engagement with contact 22 to

thereby interrupt the circuit traced above for supplying energy to the motor, while contact 17 is moved out of engagement with contact 20 to interrupt the circuit of relay RC so that its contact 32 releases and additionally interrupts the circuit of the switch motor.

Similarly, if while the switch is in its reverse position the operator desires to move it to its normal position, he can do so by moving the switch control lever L to its normal position. On this movement of the lever L, contact L1 interrupts connection from the battery to the reverse wire 12 and connects the battery to the normal wire 11, while contact L2 transfers connection of the relay X from the normal to the reverse wire.

On connection of the battery to the normal wire 11, energy is supplied to the relay NC over the circuit which is traced from wire 11 through the winding of relay NC, contacts 21 and 17, common wire 15, and front contact 30 of relay CR to the negative terminal of the battery 10. Accordingly, contact 31 of relay NC is picked up and establishes the circuit to supply energy to the motor M to cause it to move the switch to its normal position. The circuit for supplying energy to the motor M is traced from the positive terminal of the battery 10 through front contact 25 of relay CR, resistance 26 and winding of relay OR in multiple, contact L1 in its normal position, wire 11, front contact 31 of relay NC, motor armature 34, back contact 32 of relay RC, contacts 23 and 18, motor field winding 35, common wire 15, and front contact 30 of relay CR to the negative terminal of the battery. The motor, therefore, operates to move the switch to its normal position, and when the switch reaches its normal position, contact 18 is moved out of engagement with contact 23 to interrupt the supply of energy to the switch motor, while contact 17 is moved out of engagement with contact 21 to interrupt the circuit of relay NC so that its contact 31 releases and additionally interrupts the circuit of the switch motor.

It will be seen that each of the circuits for supplying energy to the switch motor includes in series therewith the resistance 26 and the winding of relay OR. The relay OR and the resistance 26 are proportioned so that under normal conditions most of the energy supplied to the motor M is supplied through the resistance 26 and too little energy is supplied through the winding of the relay OR to pick up the relay contact. Accordingly, contact 27 of relay OR remains released and maintains the circuit of relay CR so that the contacts of relay CR remain picked up in readiness to supply energy to the switch motor.

Furthermore, the relay OR is of a type the contacts of which are slow to pick up so that they will not become picked up on momentary abnormally high current flow in the motor circuit, such as occurs when movement of the switch is initiated, or when the switch is reversed in mid-stroke.

The resistance 26 has a thermal coefficient of resistance such that the resistance of the unit increases as the temperature of the material of which the unit is constructed increases. Accordingly, if the motor draws current of unusually high value for an abnormally long period, as occurs when movement of the switch is obstructed, the resistance 26 will become heated to a temperature such that its resistance increases to a degree effective to cause the current supplied through the winding of the overload relay

OR to be great enough to pick up the relay contact 27.

When contact 27 of relay OR picks up, it interrupts the stick circuit of the relay CR and contacts 25 and 30 of this relay release and cut off the supply of energy from the battery to the switch motor, and also to whichever control relay is energized. In addition, on release of the relay CR, the supply of energy to the overload relay OR is cut off and its contact 27 releases, while release of contact 25 of relay CR interrupts the stick circuit for this relay so that on release of contact 27 of relay OR energy will not be supplied to relay CR and the contacts of this relay will remain released.

On release of relay CR, contact 25 establishes the circuit of the indication lamp K and this lamp is lighted to indicate to the operator that the supply of energy to the switch motor has been interrupted.

This system is arranged so that the operator may quickly regain control of the switch after an overload. In order to secure control of the switch when the relay CR is released, the lever L is moved to its center position C so that contact L3 establishes the pick-up circuit for relay CR. This circuit is traced from the positive terminal of the battery through contact L3, back contact 27 of overload relay OR, normal polar contact 28 of relay X, and winding of relay CR to the negative terminal of the battery. Accordingly, the contacts of relay CR pick up so that contact 25 establishes the stick circuit for the relay and also establishes connection from the positive terminal of the battery to contact L1 so that energy may be supplied through this contact to the control relays and to the switch motor.

In addition, on picking up of relay CR, contact 25 interrupts the supply of energy to the lamp K, while contact 30 establishes connection from the negative terminal of the battery to wire 15.

The operator may now move the lever L to either its normal or its reverse position to energize one or the other of the control relays and thus cause the switch motor to be energized to move the switch to one position or the other.

The system of this invention is arranged so that the cross detecting relay X controls the relay CR so that in the event that energy is improperly supplied to the relay X, this relay will interrupt the circuit of the relay CR and cause it to interrupt the supply of energy from the battery and thus prevent movement of the switch.

The circuit of the relay X is controlled by contact L2 in such manner that the winding of this relay is connected to the wire 11 or 12 other than that to which connection is established from the battery by contact L1. As a result, when the equipment is functioning as intended, energy is not supplied to the relay X and its contact 28 remains in its normal position and maintains the circuit of the relay CR.

However, if while the lever L is in its normal position a cross develops between the wires 11 and 12, or if for any other reason connection is established from the positive terminal of the battery 10 to the relay X, the direction of flow of this energy through the winding of relay X is such that the contact 28 of the relay is moved to its right-hand or reverse position. On this movement of the contact 28 it interrupts the

circuit of relay CR so that contacts 25 and 30 of the relay CR release and cut off the supply of energy from the battery 10. This prevents energization of either control relay or the switch motor and thus prevents movement of the switch after such a cross or other defects in the system has developed.

In addition, on release of relay CR, contact 25 establishes the circuit of the lamp K and this lamp is lighted to indicate to the operator that a possible defect may be present.

Similarly, if while the lever L is in its reverse position, energy is supplied to the normal wire 11, the relay X will be energized and its contact 28 will interrupt the circuit of the relay CR.

This system is arranged so that the contact 28 of relay X is included in the pick-up circuit of relay CR so that after movement of contact 28 to its reverse position, the pick-up circuit for the relay CR will not be established on movement of the control lever L to its intermediate position. Accordingly, after the relay X detects a defect in the system and relay CR releases and prevents movement of the switch, the operator cannot regain control of the switch by manipulation of the control lever L. The inability of the operator to secure control of the switch will inform him that there is a defect in the equipment and that he must take steps to have this defect corrected. After the maintainer corrects the defect, he may cause movement of the contacts of relay X to their normal or left-hand position by suitable means, such as push button PB.

As the relay X controls only the current of the relay CR, the relay X may be of much lighter and less expensive construction than is required when the motor current is controlled over contacts of the relay X.

In Fig. 2 of the drawing there is shown a modification which provides increased protection against crosses between the wires connecting the control point and the switch. The modification shown in Fig. 2 of the drawing is particularly desirable where two or more switches are governed from the same control point and are controlled and operated by energy supplied from the same source. In such situations the modification shown in Fig. 2 of the drawing operates to detect crosses between the wires associated with different switches as well as between the wires for one switch.

In the diagram forming Fig. 2 of the drawing the equipment for controlling two switches is shown but it should be understood that the invention is applicable to situations where more than two switches are involved.

Referring to Fig. 2 of the drawing, there is shown therein a first switch control lever 1L which controls a first switch 1W, and a second control lever 2L which controls a second switch 2W. The equipment in the field for each switch is the same as that shown in connection with the switch shown in Fig. 1.

The equipment associated with each control lever is the same as that shown in Fig. 1 except for the substitution of a cross detecting relay XR for the cross detecting relay X employed in the system shown in Fig. 1. Each relay XR has a winding 40 which is connected in series with the wire leading from the positive terminal of the battery 10 to the associated lever contact L1, and a winding 41 which is connected in series with the connection from the associated common wire 15 to the negative terminal of the battery 10. Each relay XR has a normally released contact

42 which is included in the circuits of the associated relay CR.

The circuits of the windings 40 and 41 of each relay XR are arranged so that energy flows through winding 40 in one direction and through winding 41 in the other direction. As a result, these windings offset each other and if they are equally energized, contact 42 of the relay will remain released and maintain the circuit of the associated relay CR. However, if for any reason these windings are unequally energized, the contact 42 will be picked up and will interrupt the circuit of the relay CR.

In the modification shown in Fig. 2 the contact L2 associated with each control lever establishes connection between the associated reverse and common wires when the lever is in its normal position, and establishes connection between the associated normal and common wires when the lever is in its reverse position.

The equipment is shown in the condition which it assumes when the control levers 1L and 2L, and the switches 1W and 2W are in their normal positions.

At this time relay 1CR is energized by current supplied over its stick circuit which is traced from the positive terminal of the battery 10 through front contact 25 of relay 1CR, back contact 42 of relay 1XR, back contact 27 of relay 1OR, and winding of relay 1CR to the negative terminal of the battery 10.

The relay 2CR is energized by current supplied over its stick circuit which is similar to that traced for relay 1CR.

As the control lever 1L is in its normal position, its contact L1 establishes connection from the positive terminal of the battery 10 to normal wire 11. This connection includes in series therewith the winding 40 of relay 1XR. As the switch 1W is in its normal position, switch operated contact 17 interrupts the circuit of relay 1NC, while switch operated contact 18 interrupts the circuit for supplying energy from normal wire 11 to the switch motor 1M. Accordingly, under these conditions no energy is supplied through winding 40 of relay 1XR, nor is energy supplied through winding 41 of relay 1XR, which is included in series with the connection from the common wire 15 leading from switch 1W to the negative terminal of the battery 10. As the windings of relay 1XR are both deenergized, the contact 42 of this relay is released.

The equipment associated with control lever 2L operates in the same manner as that associated with lever 1L and a detailed description thereof is unnecessary.

On movement of the control lever 1L to its reverse position energy is supplied to the reverse control relay 1RC and to the switch motor 1M over the reverse wire 12 and the common wire 15, as explained in detail in connection with the system shown in Fig. 1. As the winding 40 of relay 1XR is in series with the connection from the positive terminal of the battery 10 to wire 12, and the winding 41 of relay 1XR is in series with the connection from wire 15 to the negative terminal of the battery, these windings are energized with current of equal value and the contact 42 of the relay 1XR remains released, while when the switch 1W reaches its reverse position and contacts 17 and 18 cut off the supply of energy to the switch motor 1M and to the relay 1RC, the windings of relay 1XR are both deenergized.

In like manner on movement of the control

lever 1L from its reverse to its normal position when the switch 1W is in its reverse position, energy is supplied over normal wire 11 and common wire 15 to the relay 1NC and the switch motor 1M, while the two windings of relay 1XR are energized with current of equal value so that the contact 42 of this relay remains released and maintains the circuit of relay 1CR.

If movement of the switch 1W is obstructed so that the switch motor draws excessive current for an abnormal period, the contact 27 of relay 1OR will be picked up, as explained in connection with the system shown in Fig. 1, and will interrupt the stick circuit of relay 1CR so that contacts 25 and 30 of relay 1CR release and interrupt the supply of energy from the battery 10 to the switch motor 1M and the associated control relays. It will be observed, however, that release of the relay 1CR does not affect the supply of energy from battery 10 to the equipment associated with switch 2W. Similarly, release of the relay 2CR will not affect the supply of energy to the equipment associated with switch 1W.

If, while the lever 1L is in either its normal or its reverse position and the switch 1W is in the corresponding position, a cross develops from the positive terminal of the battery to the common wire 15 associated with switch 1W, the winding 41 of relay 1XR will be energized and contact 42 of this relay will be picked up to interrupt the circuit of relay 1CR. Accordingly, relay 1CR releases and its contact 25 interrupts connection from the positive terminal of the battery 10 to the associated lever contact 1L and also interrupts the circuit of its own winding so that on release of relay 1XR energy is not supplied to relay 1CR and the contacts of this relay remain released. In addition, on release of relay 1CR contact 25 establishes the circuit of the lamp 1K, while contact 30 interrupts connection from the associated wire 15 to the negative terminal of the battery. On release of relay 1CR, therefore, the supply of energy from the battery 10 to the wires leading to switch 1W is cut off, while the circuits of the windings of relay 1XR are interrupted so that neither of these windings can be energized and contact 42 of the relay 1XR is released to permit the pick-up circuit of relay 1CR to be established.

Likewise, a cross from the positive terminal of the battery to reverse wire 12 at a time when the lever 1L is in its normal position will result in energization of the winding 41 of relay 1XR. Under these conditions, energy may be supplied to winding 41 over two paths. One of these is traced from wire 12 through lever contact L2, wire 15, front contact 30 of relay 1CR, and winding 41 of relay 1XR to the negative terminal of the battery. The other path is traced from wire 12 through the winding of relay 1RC, contacts 20 and 17, wire 15, front contact 30 of relay 1CR, and winding 41 of relay 1XR to the negative terminal of the battery.

As a result of the supply of energy to winding 41, contact 42 of relay 1XR picks up and interrupts the circuit of relay 1CR and the contacts of relay 1CR release and prevent the supply of energy from the battery 10 to the motor 1M or the associated control relays, while contact 30 of relay 1CR interrupts the circuit of the winding 41 of relay 1XR so that contact 42 of relay 1XR releases to permit the pick-up

circuit of relay ICR to be established on movement of the lever 1L to its center position.

Similarly, a cross from the positive terminal of the battery to normal wire 11 at a time when the lever 1L is in its reverse position will result in energization of the winding 41 of relay 1XR. Under these conditions, energy may be supplied to winding 41 over the path which is traced from wire 11 through contact L2, wire 15, front contact 30 of relay ICR, and winding 41 of relay 1XR to the negative terminal of the battery 10. Energy may also be supplied to the winding 41 over the path which is traced from wire 11 through winding of relay INC, contacts 21 and 17, wire 15, front contact 30 of relay ICR, and winding 41 to the negative terminal of the battery. Contact 42 of relay 1XR will, therefore, be picked up to interrupt the circuit of relay ICR, as explained above.

The system shown in Fig. 2 of the drawing is arranged so that if a cross develops between the common wires associated with different switches, it will be detected by the relays XR as soon as an attempt is made to move either of these switches.

If a cross develops between the common wire 15 for switch 1W and the common wire 15 for switch 2W at a time when the switch control levers and the switches are in correspondence, no energy is supplied over either wire and the cross will not cause picking up of either relay XR, but as soon as an attempt is made to move either switch, one or both of the relays XR will be energized to thereby prevent movement of the switches.

If under these conditions the control lever 1L is moved to its other position so that energy is supplied from the positive terminal of the battery 10 over the normal or reverse wire to one of the control relays and to the motor 1M, all of the energy supplied from the battery will flow through the winding 40 of relay 1XR. However, because of the cross which is assumed to exist between the common wires 15 only a portion of this energy flows through winding 41 of relay 1XR to the negative terminal of the battery. The remainder of the energy flows from wire 15 associated with switch 1W through the assumed cross to the wire 15 associated with switch 2W and thence through winding 41 of relay 2XR to the negative terminal of the battery.

Since under these conditions all of the energy supplied from the battery flows through the winding 40 of relay 1XR, and only a portion of this energy flows through the winding 41 of this relay, these windings do not offset each other and the contact 42 of relay 1XR is picked up and interrupts the circuit of the relay ICR so that its contacts 25 and 30 release and cut off the supply of energy from the battery 10 to the wires leading to the switch 1W. In addition, contact 25 of relay ICR interrupts the supply of energy to this relay and establishes the circuit of the indication lamp 1K.

On release of relay ICR and consequent interruption of the supply of energy from the battery to the wires associated with switch 1W, the windings 40 and 41 of relay 1XR are both deenergized and contact 42 of the relay releases, but relay ICR remains released and prevents the supply of energy from the battery to the wires associated with switch 1W.

After release of the relay ICR, whether caused by picking up of relay 1XR or overload relay IOR, the operator may regain control of the

switch by moving the control lever 1L to its center or intermediate position C. In this position of the lever, contact L3 establishes the pick-up circuit for relay ICR. This circuit is traced from the positive terminal of the battery through contact L3, back contact 42 of relay 1XR, back contact 27 of relay IOR, and winding of relay ICR to the negative terminal of the battery. On picking up of the relay ICR its contact 25 interrupts the circuit of the lamp 1K and establishes the stick circuit for relay ICR to keep the relay energized after movement of the lever 1L from its center position, while contact 30 of relay ICR establishes connection from wire 15 to the negative terminal of the battery.

The operator may now move the lever 1L to either its normal or its reverse position to move the switch, but if the overload or defective wiring condition which caused release of the relay ICR is still present, this relay will again release and prevent movement of the switch, while inability of the operator to move the switch will inform him that there is a defect in the apparatus which must be corrected.

As pointed out above, if there is a cross between the common wires 15 for the switches 1W and 2W, and an attempt is made to move switch 1W, energy will be supplied to the winding 41 of relay 2XR. This energy may pick up the contact 42 of this relay so that the circuit of relay 2CR is interrupted and this relay releases and prevents the supply of energy to switch motor 2M. If the relay 2CR releases, it may be picked up by moving the lever 2L to its intermediate position, but if the cross between the common wires for switches 1W and 2W is still present when the attempt is made to move switch 2W, contact 42 of relay 2XR will pick up and interrupt the circuit of relay 2CR, while contact 42 of relay 1XR may also be picked up to interrupt the circuit of relay ICR.

From the foregoing it will be seen that the systems provided by this invention are arranged so that an overload relay of standard design may be employed to detect abnormal flow of current from the source, and on such an occurrence to cut off further supply of energy from the source. The systems are arranged so that after an overload the operator may regain control of the switch by moving the control lever to its intermediate position. This permits the operator to move the switch away from an obstruction which caused the overload.

In each of the systems provided by this invention the overload relay operates through a contactor to control the supply of energy from the source, and this contactor when released interrupts connection from both terminals of the source so that the source is completely isolated from the circuits in which the overload occurred.

In addition, each form of the invention employs a cross detecting relay which controls the contactor, while the system shown in Fig. 2 employs an improved form of cross detecting relay which responds to certain additional defects. These systems are arranged so that the cross protection relays do not directly control the supply of energy from the source, but do so through the contactor so that these relays do not need to be of sufficient capacity to control the circuits of the switch motors.

Although the apparatus embodying my invention is shown applied to cross and overload protection of railway track switch motors, it will be apparent that this apparatus has broader

utility and may be used to protect any suitable electrical apparatus which may be subject to an overload and to undesired operation due to a cross in its control or operating circuits.

Although I have herein shown and described only two forms of control systems embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claim without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

In combination, a track switch, a motor for moving said switch, a source of current located at a control point, a normal, a reverse and a common wire extending from said control point to said switch and over which energy may be supplied from said source to said motor, said common wire being connected to one terminal of said source, manually controlled means for at times establishing connection from the other terminal of said source to said normal wire and for at other times establishing connection from the other terminal of said source to said reverse wire, a normal circuit including said normal and common wires for operating said motor, a re-

verse circuit including said reverse and common wires for operating said motor, a contactor having a contact which when released interrupts the supply of energy from said source to said

- 5 normal and reverse circuits, an overload relay responsive to the value of the current supplied to said normal and reverse circuits, said relay having a normally released contact which becomes picked up on abnormal current flow in
- 10 said circuits, a cross detecting relay having one terminal of its winding connected to said common wire and having the other terminal of its winding connected to the normal or reverse wire according as said manually controlled means
- 15 establishes connection from said source to said reverse or said normal wire, said cross detecting relay having a normally closed contact which is opened on flow of energy through the relay winding and which when opened remains open when
- 20 flow of energy through the relay winding ceases, a stick circuit for said contactor including its own front contact, said cross detecting relay contact and a back contact of said overload relay, and a pick-up circuit for said contactor including
- 25 said cross detecting relay contact.

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