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[54] **SIGNAL TRANSMISSION ARRANGEMENTS FOR RAILROAD INTERLOCKINGS**
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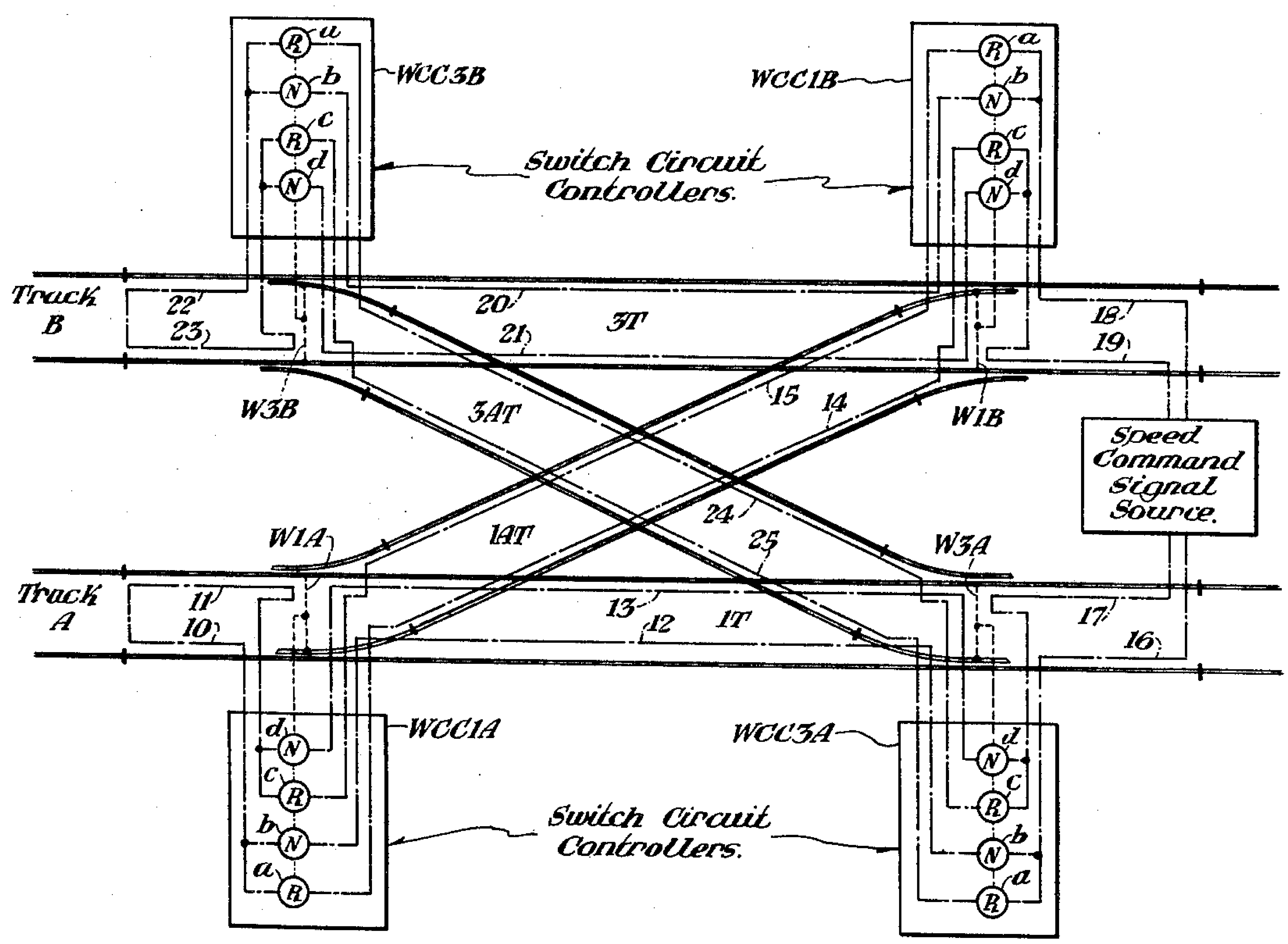
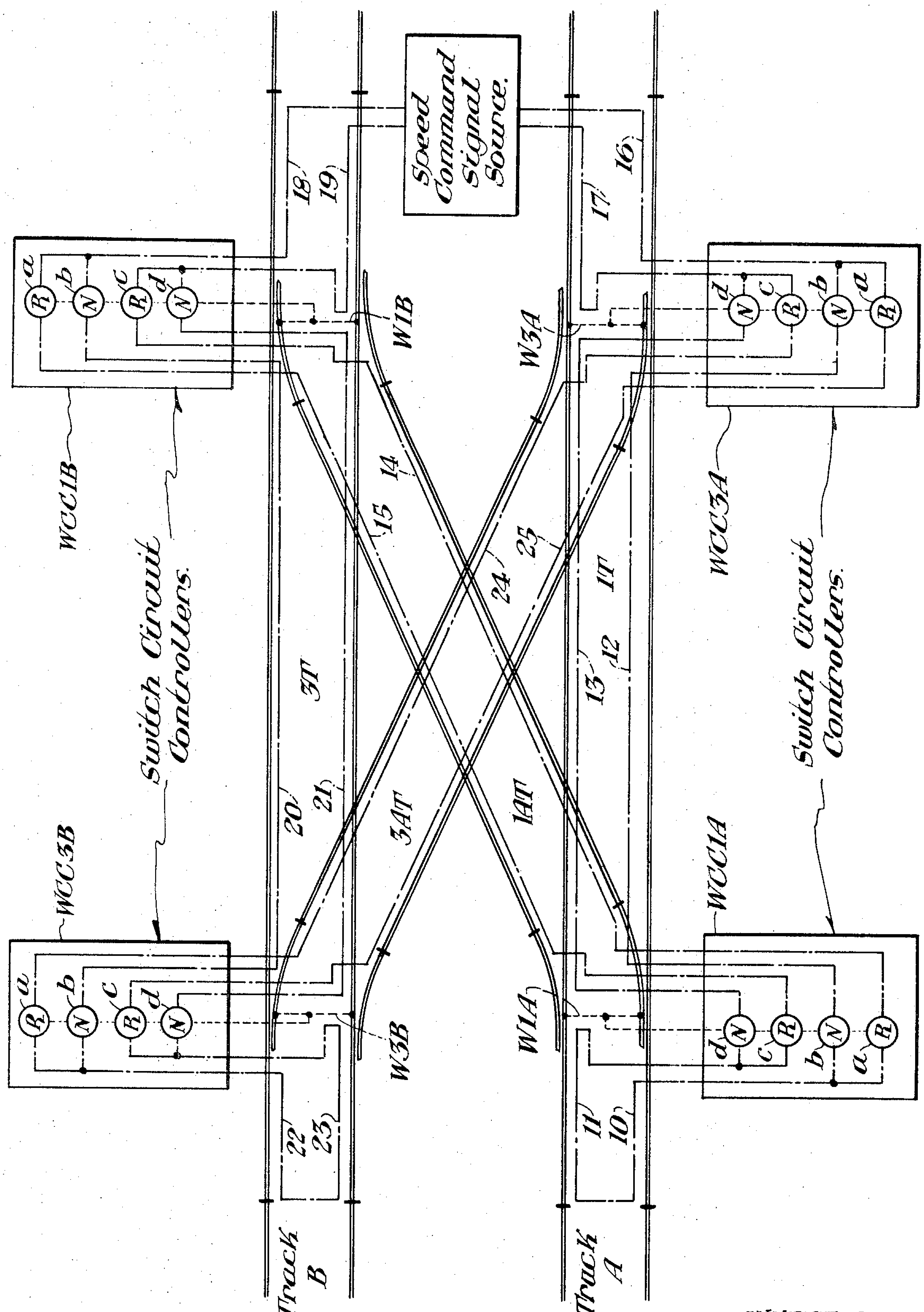
ABSTRACT: A single wire is laid adjacent to each rail in each separate track section within a railroad interlocking. The wires in each section do not form a complete loop but rather are connected to contacts of the switch circuit controller associated with the track switch at each end of that section, specifically to those contacts which close when that section is included in an established route. When a route is established, the circuit controller contacts connect the wires of selected sections into a completed loop circuit parallel to the rails along that route. This loop circuit is supplied with speed command signals to which train carried speed control apparatus responds in the same manner as to signals transmitted conventionally through the rails.





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SIGNAL TRANSMISSION ARRANGEMENTS FOR RAILROAD INTERLOCKINGS

This invention pertains to a signal transmission arrangement for railroad interlockings. More particularly, my invention relates to an improved arrangement for establishing an independent transmission path for speed command signals which corresponds to the established route through an interlocking.

In all automatic train operation or speed control systems, it is essential that a practical method be employed that allows continuous communications between train and wayside control apparatus. One specific requirement is to constantly transmit to the train its allowable speed in all parts of the territory through which the train operates. One of these methods, conventionally used, is the transmission of electrical signals, corresponding to the respective speed commands, through the running rails of the track and thence to the train by electrical induction through receiver coils mounted on the train above the rails. Although the advantages of this method have been proven by its application to many systems over a long period of time, one area where improvement is needed is in the transmission of such speed command signals throughout interlocking areas. Because of the rail configuration within interlocking areas, especially where electric propulsion requires special bonding between the rails for return circuits, it is possible to have sneak circuits through which the speed command signals can leak to rails over which other trains are operating, thus affecting their operation in what may be an unsafe manner. One solution to this problem is to employ wire or cable loops to transmit such speed signals throughout the interlocking area. Such loops are laid adjacent and parallel to the rails so that they will also inductively influence the train carried apparatus in the normal manner. However, this solution is effective only if it is economical in its requirements for cable runs from the signal source, that is, the source of the speed command signals. In other words, an efficient arrangement is needed to connect the wire into the desired transmission loops throughout the interlocking limits.

Accordingly, an object of my invention is an improved arrangement assuring continuous communication between train carried and wayside apparatus while a train traverses a route through an interlocking.

A more specific object of my invention is an improved arrangement for transmitting speed command signals for train control purposes throughout a railroad interlocking area.

It is another object of my invention to provide an arrangement of loop circuits throughout a railroad interlocking area for transmitting signals between wayside apparatus and associated apparatus on train traversing the interlocking routes.

A further object of my invention is the use of wire or cable laid adjacent to the rails in a railroad interlocking and connected into circuit loops in accordance with the established routes to transmit speed commands to train control apparatus carried by trains traversing those routes.

Still another object of my invention is a speed signal transmission circuit arrangement for railroad interlocking areas in which wires laid parallel to the rails in each separate track section are connected over contacts of switch circuit controllers to form a single completed circuit loop for such speed signal transmission in accordance with the established route for a train.

Other objects, features, and advantages of my invention will become apparent from the following description when taken in connection with the appended claims.

In practicing my invention, a single wire or single wire cable is laid parallel to each rail at all points throughout the interlocking limits. The pair of wires along the rails for each separate track portion or section within this interlocking do not of themselves form a loop circuit but are connected to contacts of the well-known switch circuit controllers associated with the track switches at each end of such sections. Each pair of wires is connected to the circuit controller contacts which correspond to the switch position for the route which will, when established, include that particular track section. At selected outer limits of the interlocking, the wires along the rails are cross-connected to form a partial loop or, as specifically illustrated, may be connected to a source of energy for the speed command signals. When the desired route through the interlocking area is established for an approaching train, the contacts of the switch circuit controllers are positioned, i.e., are closed, in a corresponding manner. Specifically, the circuit controller contacts, when closed to correspond to the switch positions for the established route, connect selected pairs of section wires into a completed loop circuit. This loop circuit then lies parallel to the rails along the entire route established for the approaching train. This loop circuit is preconnected at one end of the interlocking route or at any other desired location to the wayside apparatus, specifically shown as a source of speed command signals. This provides a complete circuit for the transmission of the speed command signals along the route of the train. Trains traversing this interlocking are equipped with apparatus responsive to such signals to control the speed of the train or to display indication for the train operator to so control his train. It is well known in such systems that speed command signals are normally transmitted through the rails and are inductively picked up by the train carried apparatus through receivers carried at the head end of the train. However, the wire loops provided by the arrangement of my invention are so positioned that the signals transmitted therein also inductively actuate these receiver coils and thus control the train apparatus. This supplies the speed command signals to the train within the interlocking limits without a complicated arrangement of insulated joints, impedance bonds for the propulsion current, and cross bonding between sections and around switches, and also eliminates multiple feed points for such signals.

Although in the following detailed description and in the drawing the arrangement provided by my invention is applied to a train control/speed control system, it is to be understood that other types of signals or communications may also be transmitted to or from the train using the completed wire loops formed in the systems including my invention.

I shall now describe in greater detail a typical arrangement embodying the system of my invention as schematically shown in the single drawing FIGURE which is an illustration of a simple railroad interlocking equipped with the speed command transmission loops.

Across the center of the drawing FIGURE are shown stretches of two railroad tracks, illustrated as parallel sets of double solid lines and designated as track A and track B from bottom to top, respectively. Trains may move in either direction over these railroad tracks. As specifically illustrated, the two tracks are connected by two crossovers to allow movement of trains in either direction between the two tracks. The crossovers are shown in the well-known scissors layout but, of course, my invention is not limited to such arrangements. Further, my invention is not limited to simple interlocking arrangements incorporating only crossovers between parallel pairs of railroad tracks but may be applied, as will become apparent, to more complicated interlocking arrangements known throughout the art. In the relatively small interlocking layout illustrated in the drawing FIGURE, it is assumed that control of the interlocking, and particularly the switches, is exercised from a remote control office. However, this is not a critical point in the inventive concept disclosed herein.

To simplify the following description, the outer limits of the interlocking, for control and train detection purposes, are defined by insulated joints in both rails of the two main tracks A and B. These insulated joints, and other such joints shown, are illustrated by conventional symbols. The stretches of the two main tracks within the outer limits, that is, between the insulated joints, are designated as section 1T in track A and section 3T in track B. It is to be noted that the crossover track portions are insulated from the main tracks and are designated as section 1AT for train movements left to right from track A to track B and section 3AT for train movements from track B to track A, left to right. Each insulated track section is assumed to be provided with a track circuit arrangement for train detection purposes, although these are not shown since this function is not part of the invention. However, it will be understood by those familiar with the signaling art that, depending upon the specific type of train detection used, the manner of defining the outer limits of the interlocking may vary. For example, if single rail track circuits are in use in electric propulsion territory, only an insulated joint in one rail at each outer limit will be used. The use of high-frequency type track circuits may eliminate the need for any insulated joints. It will also be understood that, although not herein shown, impedance bonds will be necessary to complete a propulsion current return path around insulated joints if used in both rails.

Each crossover is connected at each end to the main track by a track switch shown in a conventional manner. For the crossover including section 1AT, the switches are designated as switch W1A at the track A end and switch W1B at the track B end. Correspondingly, the switches for the crossover including section 3AT are designated as switches W3A and W3B. The switches at each end of a particular crossover, assumed to be remotely controlled, operate as a pair. In other words, the switches of each pair are both positioned normal to allow trains in the corresponding main tracks to move straight through or are both in the reverse position to direct trains through the crossover section. This is consistent with remote control of interlockings, as is understood in the art, and needs no further explanation. Each switch is illustrated as being equipped with a point detector rod, shown as a dotted line between the conventionally shown switch points. As is usual in operation of switches, this point detector rod moves with the switch points, being connected thereto and having an insulated portion to avoid shunting any track circuits that are in use.

Each switch is also provided with a switch circuit controller, shown as a solid line block designated by the general reference character WCC, each with a suffix corresponding to the suffix designated the switch itself. Thus for switch W1A, a switch circuit controller WCC1A is illustrated. For purposes of the description herein, each switch circuit controller is shown as having four contact sets, designated *a*, *b*, *c*, and *d*. Each is shown conventionally by a circle with a letter inside to designate when that particular contact set is closed, that is, whether the switch is normal (N) or reverse (R). Such circuit controllers are normally physically located immediately adjacent the switch and their contacts are controlled by the switch point detector rod, as conventionally illustrated by the dotted line from the center of each such rod connecting to each of the four contacts of the associated switch circuit controller. This control is so exercised that the circuit controller contacts close to repeat the position of the switch. Normally other contact sets, not shown herein, are provided within such circuit controllers to be used for indication of switch positions and for safety signal control purposes. The description of such contacts is not necessary for understanding the invention described herein.

The system of my invention adds a wire or a single conductor cable laid parallel to each rail throughout the interlocking, that is, in each of the various track portions or sections of the interlocking located between switches or within outer limits. This is illustrated in the drawing by the dot-dash lines drawn adjacent to and between the solid line sets representing the rails of each track. In actual practice, these wires or cables must be so positioned adjacent the rail as to be the equivalent of the rail to the train carried receiver coils of the speed control apparatus on each train. Thus a pair of such wires extends along the rails of each separate and distinct track portion or section within the interlocking area. Although it is physically impossible to completely illustrate, it will be understood that the wires are placed adjacent to all portions of the rail including the switch points without leaving extensive gaps between ends of such wire sections. The pair of wires for each track section terminate at the switch location at each end of the section or at the outer limits of the interlocking area. For an example of the latter case, wires **10** and **11**, in the track portion or section between the insulated joints at the left end of track A and switch W1A, are terminated at the outer limit of the interlocking by a cross connection between the two wires. As another example, in the section between switches W1A and W3A in track A, wires **12** and **13** extend only between the switch detector rod locations of these two switches. Further, in crossover section 1AT, wires **14** and **15** extend between the detector rods for switches W1A and W1B.

Actually, at each switch location, the pair of wires from a particular track section terminate in contacts of the switch circuit controllers associated with that switch. The selected contacts for each pair of wires are those closed when the switch position is such as to include the track section within an established route. For example, wires **12** and **13** in section 1T are connected to N contacts *b* and *d*, respectively, of switch circuit controllers WCC1A and WCC3A, since each of these switches will be in a normal position to include that portion of track A within an established route. Explaining further, wires **14** and **15** in section 1AT are connected to the R contacts *a* and *c* in switch circuit controllers WCC1A and WCC1B, since switches W1A and W1B will be positioned reverse to include section 1AT of the crossover within an established route through the interlocking. As an example of the outer portions of the interlocking area, wire **10** is connected in multiple to contacts *a* and *b* while wire **11** is connected in multiple to contacts *c* and *d* of switch circuit controller WCC1A. This is necessary since this particular outer subsection of track A can be included in two possible routes, that is, straight through on track A and a diverting route from track A over crossover 1AT to track B. As already explained, wires **10** and **11** are cross-connected to form a partial loop circuit at the outer limit of the interlocking, that is, at the insulated joints.

Wires **16** and **17** in the right end portion of track A included within the interlocking are connected to contacts of switch circuit controller WCC3A in a manner similar to that used for wires **10** and **11**. However, at the outer end of the interlocking, wires **16** and **17** are shown connected to a source of speed command signals illustrated by a conventional solid line block so designated. The speed command signals supplied by the source must, of course, be of a type proper to control the train control or speed control apparatus carried by trains operating over the tracks of the system which includes this interlocking. Several well-known types of train control systems with appropriate types of signals may be used and still incorporate the wire loops of my invention. As a specific example, the train or speed control system, here designated by the source only, may be similar to that shown in U.S. Pat. No. 3,328,580 issued June 27, 1967 to C. E. Staples for a Rapid Transit Speed Control System. As is well known in the signaling art, speed command signals are normally carried by current flowing through the rails and are received by the train apparatus through inductive coupling between the rails and train carried receiver coils positioned over the rails. However, in the arrangement of my invention, the previously described wires replace the rails, but are so positioned as to provide an equivalent inductive coupling with train carried receiver coils so that the command signals may be received on board the train by the apparatus. It is to be understood that, depending upon the specific layout of an interlocking, the pair of wires at each outer limit may be cross-connected as are wires **10** and **11** and connections to the single source then made at other locations within the interlocking.

I shall now describe the operation of the arrangement of my invention during the passage of trains through the interlocking. It will be assumed that the first train to be described will move left to right along track A straight through the interlocking arrangement, that is, will not be diverted to the crossover. This requires that a route be established with all switches in their normal positions. Obviously, switches W1A and W3A must be positioned normal for a straight through move on track A. Therefore, since the switches at each end of a crossover track operate together and to identical positions, switches W1B and W3B will also occupy their normal positions as the route is established by remote control. Actually, it is also a safety requirement in interlocking operation that, under the assumed conditions, the switches in track B be in their normal positions and this positioning must be checked for compliance before signals can be cleared for the train to travel along its desired route. With the switches thus positioned, a loop circuit for transmission of speed command signals to the train is completed. Beginning at the speed command signal source, this loop circuit may be traced from the lower right-hand output lead over wire **16**, N contact *b* of switch circuit controller WCC3A, wire **12**, N contact *b* of circuit controller WCC1A, wire **10** which is cross connected to wire **11**, N contact *d* of circuit controller WCC1A, wire **13**, N contact *d* of circuit controller WCC3A, and wire **17** to the lower left-hand lead of the signal source. Since this is a complete loop circuit, the train, as it moves through the interlocking, will receive continuous speed command signals by the inductive coupling of its receivers with the wire loop just traced. As was previously noted, the various wires on each side of the switch locations are brought into as close a proximity as is physically possible so that the gaps in the signal pickup are inconsequential to the operation of the train carried apparatus.

It may be also noted that a loop circuit for a parallel movement on track B is simultaneously completed since switches W1B and W3B must be positioned normal during the establishment of the route for the first train. This parallel route loop circuit includes wires **18** and **19**, N contacts *b* and *d* of circuit controller WCC1B, wires **20** and **21**, N contacts *b* and *d* of circuit controller WCC3B, and wires **22** and **23**, cross-connected at their outer ends, the signals being supplied over the upper output leads of the signal source. It is to be understood that a parallel move by another train over this route, receiving its speed command signals from the last traced loop circuit, will not conflict safetywise or in any way with the route established for the first assumed train. Thus it is proper within the safety requirements for interlocking operations that, under the assumed route establishment, two loop circuits may be completed for parallel moves of two trains. However, the speed command signals supplied to each loop, since they reflect the advance traffic conditions along the subsequent route to be followed by that train, will not necessarily be of identical character as to allowed speed.

It is now assumed that another movement is desired from left to right with the train moving from track A over crossover section 1AT to track B. In order to establish a route for this move by remote control, switches W1A and W1B are positioned reverse, while switches W3A and W3 are held in, or are moved into, their normal positions. As part of the establishment of the route, and to meet all safety requirements, no signal can be cleared to authorize a train movement over switch W3B into section 3T along the track B, nor any reverse train movement over switch W3A into section 1T. With the route established, a loop circuit for the speed command signals is completed over the wires which parallel the route to be followed. This circuit may be traced from the upper output of the speed command signal source over wire **18**, R contact *a* of circuit controller WCC1B, wire **15**, R contact *c* of circuit controller WCC1A, wire **11**, the cross connection and wire **10**, R contact *a* of controller WCC1A wire **14**, R contact *c* of controller WCC1B, and wire **19** to the signal source. Transmission of the signals over this completed loop circuit assures that such signals will be received to control the train's operation during its passage through the interlocking across the crossover track. It is to be noted that, although wires **16** and **17** are connected, respectively, to wires **12** and **13** because N contacts *b* and *d* of circuit controller WCC3A are closed, this partial circuit is incomplete since there is no connection from wires **12** and **13** over the open N contacts *b* and *d* of circuit controller WCC1A. Also, wires **24** and **25** in the crossover including section 3AT are open at both ends since the R contacts of circuit controllers WCC3A and WCC3B are open with these switches in their normal position. Any possible circuit including wires **22** and **23** and wires **20** and **21**, which are connected over the N contacts of controller WCC3B, is open at the N contacts *b* and *d* of circuit controller WCC1B. Thus no other loop circuit for any conflicting move is completed at this time to transmit speed command signals to any other train in the interlocking.

It is to be noted that in each case described above, an opposite direction move by a train along the established route will also receive speed command signals. In other words, since the speed command signals are transmitted through wires which have no physical contact with the train, there is no shunting of signals by the train moving along an established route as there is if signals are being transmitted through the rails. This is a convenient advantage since the speed command circuits do not have to be reversible within the interlocking limits, which reduces the amount of external cabling from the speed command signal source required in order to furnish the signals throughout the interlocking area. It may be noted also, of course, that the single connection to the output leads from the speed command source to each of the described loop circuits is sufficient and multiple connections do not have to be made to short wire loops within the sections which constitute the established route. The circuits for other possible routes established throughout this interlocking may be traced by reference to the preceding descriptions and to the accompanying drawing, if desired. However, such loop circuits are not described herein as they are not necessary to further an understanding of the arrangement of my invention. If a more complicated interlocking is provided with this type arrangement, it will be obvious to those skilled in the art that similar connections between parallel wires within each of the separate track portions within the interlocking may be accomplished over contacts of switch circuit controllers closed in accordance with the switch positioning which establishes the route, regardless of the complexity of the interlocking itself.

The arrangement provided by my invention thus provides a simple, yet an efficient and economical arrangement for supplying speed command signals to trains as they move through interlocking layouts. The use of the switch circuit controller contacts to connect short sections of wire, laid along and parallel to the rails in each track section, into a completed loop circuit from the signal source along the entire established route avoids lengthy runs of cable from the wayside source of the command signals to each section in each possible route. The use of these contacts also eliminates complicated switching circuits, that is, relay contact matrices, at the wayside source where direct connections to the various smaller loops would be necessary. The arrangement also make possible the use of the same loop circuits for either direction movement of trains throughout the interlocking along the same routes and eliminates providing reversible circuitry. All this is accomplished without compromising the safety since safety checks are made within the control circuits external to the wire loops and the switching. In addition, it is not possible to establish loop circuits for conflicting moves, but only for the single desired route where such is the only one possible.

Although I have herein shown and described only a single arrangement embodying the novel features of my invention, it is to be understood that various changes and modifications may be made within the scope of the appended claims without departing from the spirit and scope of my invention.

I claim:

1. A signal transmission arrangement for a railroad interlocking, said interlocking controllable to establish a selected one of at least two different routes through said interlocking for an approaching train prior to its arrival, the interlocking rails forming a plurality of distinct track sections each extending between two predetermined points within the interlocking limits, each train provided with apparatus for the transmission of selected signals between corresponding wayside and train carried apparatus, comprising in combination,

a. circuit control means responsive to the route selection for establishing predetermined circuit connections corresponding to the selected route,

b. a signal transmission wire positioned adjacent to and extending the length of each rail in each distinct track section,

c. said circuit control means connected for connecting the signal transmission wires of adjoining sections selected in accordance with the established route into a single complete loop parallel to the entire established route and including a connection to said wayside apparatus to carry the selected signals being transmitted between the train carried and wayside apparatus.

2. A signal transmission arrangement as defined in claim **1** in which said circuit control means comprise switch circuit controller contacts selectively closed in response to the positioning of the track switches of said interlocking to establish a selected route.

3. A signal transmission arrangement as defined in claim **2**, in which,

a. the transmission wires adjacent the rails in adjoining sections included in a selected route are connected over selectively closed switch circuit controller contacts to form a single complete loop parallel to the established route for a train,

b. said loop further including a preconnected cross connection between the opposite rail wires at least at one end of said established route and a connection to said wayside apparatus at a preselected point along said route to carry said signals between the train carried and wayside apparatus.

4. A signal transmission arrangement as defined in claim **2**, further including,

a. cross connections between said transmission wires adjacent opposite rails at selected ones of the points within said interlocking which may at times become an end of a selected route,

b. connections from the transmission wires to the wayside apparatus at each other point which may at times become an end of route,

c. each completed loop including the transmission wires of adjoining sections included in the established route, switch circuit controller contacts closed in accordance with the established route, a cross connection, and a wayside apparatus connection.

5. In a railroad interlocking controllable for establishing a selected one of at least two different routes for an approaching train prior to its arrival, the interlocking rails forming a plurality of distinct track sections each extending between two predetermined points within the interlocking limits, each train traversing said interlocking being provided with speed signaling apparatus controlled by speed command signals normally inductively received through the rails from a wayside source of such signals, a speed command signaling arrangement for said interlocking comprising in combination,

a. circuit control means responsive to route selection for establishing predetermined circuit connections corresponding to the selected route,

b. a signal transmission wire positioned adjacent to and extending the length of each rail in each distinct track section,

c. said circuit control means connected for connecting the signal transmission wires adjacent the rails in adjoining sections included in a selected route into a single complete loop including a connection to said wayside speed command signal source and parallel to the established route to transmit speed command signals to a train traversing the interlocking.

6. A speed command signaling arrangement as defined in claim **5** in which said circuit control means comprise a switch circuit controller for each track switch, each circuit controller having a plurality of contacts selectively closed in accordance with the switch position establishing a selected route to connect together the corresponding transmission wires of the adjoining track sections included in the established route.

7. A speed command signaling arrangement as defined in claim **6**, further including,

a. a cross connection between said transmission wires adjacent the opposite rails at selected ones of the outer limits of said interlocking which may at times become an end of an established route,

b. a connection to said wayside signal source from said transmission wires adjacent the rails at each other outer limit which may at times become the other end of an established route,

c. each completed transmission loop formed by connecting transmission wires of adjoining sections also including a cross connection, a connection to said wayside signal source, and the several switch circuit controller contacts closed in accordance with the corresponding established route.