ABSTRACT

An automated control system for the track switches on the hump tracks of a two-section classification yard having two inlet hump tracks interconnected by a cross-over, allowing manually controlled or automated routing of cars from each hump track to any destination track in either section of the yard. The control system, actuated primarily by two selector switches, affords three distinct operating conditions: (1) automated route switching from the first hump track to any classification track in either section of the yard; (2) automated route switching from the second hump track to any classification track in either section of the yard; and (3) cross-over switching from either hump track to the other under manual control. The system automatically inhibits other operating conditions to preclude erroneous operation.

8 Claims, 4 Drawing Figures
CROSS-OVER CONTROL FOR CLASSIFICATION YARD HAVING TWO HUMP TRACKS

BACKGROUND OF THE INVENTION

In a relatively large classification yard, it may be desirable to provide two inlet hump tracks to increase the overall capacity of the yard by allowing preparation work outside of the yard on one of the hump tracks while cars are being released and classified in the yard from the other inlet track. In a manually actuated yard, where the track switches in the yard are thrown under direct manual control of a tower operator, the availability of two inlet hump tracks presents no unusual problems, assuming that the operator has a substantially equal view of each of the two inlet tracks. In a yard equipped with automated route switching, however, considerable difficulty may be encountered.

Thus, in a classification yard having automatic route switching, and having two inlet tracks, a substantial confusion factor is presented because the overall route switching information for a car entering the yard along one inlet track is different from that for the same car, same destination, entering on the other inlet track. The difference arises in the interconnection or cross-over between the tracks at the upper end of the yard. A safety problem is also presented, since the cross-over between the two inlet tracks presents an additional and unusual intersection at which collisions can occur, especially if there is any error in entry of route switching data. Furthermore, when changing from the use of one inlet track to the other, confusion in destination information may result in accidents in the yard. It is also necessary, in any yard, to provide for overriding manual control of any automated route switching equipment, in the event of an accident or other malfunction in the yard, and this is made more complex by the presence of two inlet tracks and an interconnecting cross-over.

SUMMARY OF THE INVENTION

It is a principal object of the present invention, therefore, to provide a new and improved cross-over control for an automated railroad classification yard having two inlet hump tracks interconnected by a cross-over, which control effectively and inherently overcomes the difficulties set forth above.

A particular object of the invention is to provide a new and improved cross-over control, for an automated railroad classification yard having two inlet hump tracks, that allows effective use of the two tracks for routing cars to any part of the yard without an increase in the likelihood of collision or other accidents in the yard as compared with a yard having a single inlet track.

A specific object of the invention is to provide a new and improved cross-over control that enables the use of two inlet hump tracks in the operation of a railroad classification yard having automated route switching controls and that permits the entry of route switching information on a consistent basis regardless of the inlet track being used at any given time.

Accordingly, the invention relates to a cross-over control for an automated railroad classification yard including first and second yard sections each comprising a plurality of individual classification tracks with first and second substantially parallel inlet tracks leading into the first and second yard sections respectively and with a cross-over between the inlet tracks ahead of the yard sections. The cross-over includes, in each inlet track, an upstream cross-over track switch and a downstream cross-over track switch, with the upstream cross-over track switch in each inlet track connected to the downstream cross-over track switch in the other inlet track. The automated route switching apparatus for the yard includes storage means for storing route switching data to direct individual cars to each classification track in the entire yard, together with route switching means for actuating the track switches in the yard in accordance with the data stored in the storage means. The cross-over control of the invention comprises selector means actuable to any one of three operating conditions:

A. automatic route switching control using the first inlet track,
B. automatic route switching control using the second inlet track, and
C. manual control of the track switches for the cross-over.

The cross-over control further comprises first track switch control means, actuated by the selector means when the selector means is in condition A, for throwing the downstream cross-over track switch in the first inlet track to its normal position, for throwing the downstream cross-over track switch in the second inlet track to its reverse position, and for maintaining those track switches in those positions. A second track switch control means, actuated by the selector means when the selector means is in condition B, throws the downstream cross-over track switches to the opposite positions, and maintains those track switch positions.

Time delay means are provided for inhibiting actuation of either switch control means for a predetermined time interval whenever the selector means is actuated from one condition to another. Coupling means are provided for connecting the upstream cross-over track switches to the route switching data storage means for control of the upstream track switches by the storage means for control of the upstream track switches by the storage means when the selector means is in either condition A or condition B. In addition, occupancy clearance means are provided for determining whether any portion of the cross-over, including the cross-over track switches, is occupied; this clearance means inhibits actuation of the aforementioned switch control means and the coupling means whenever an occupancy condition is detected.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of an operator's control console for the cross-over control of the present invention; and FIGS. 2, 3, and 4 comprise a comprehensive detailed schematic circuit diagram for a cross-over control constructed in accordance with one embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 illustrates the operator's console 40 for the cross-over control system of the present invention. The console or control panel 40 includes all of the operating elements, such as selector switches, and the like, for
the control of the cross-over portion of a two-section classification yard having two lead-in hump tracks; the console also constitutes a map of the yard itself, since the control elements are laid out on panel 40 in the same configuration as the controlled devices, such as track switches and car retarders, in the classification yard. In the following description, any reference to tracks, track switches, retarders and the like is intended to refer both to the equipment in the yard and the representation of that equipment on console 40, unless otherwise indicated.

The classification yard displayed on console 40 includes 36 classification tracks, of which only tracks 1 through 21 are shown. The yard is divided into two sections of equal size, a "normal" section comprising tracks 1 through 18 and a "reverse" section including tracks 19 through 36. The "normal" and "reverse" designations are arbitrary and have no operational significance. The two sections of the yard are mirror images of each other, as will be apparent from a comparison of tracks 16 through 18 with tracks 19 through 21.

The yard has two lead-in or hump tracks, a "southbound" track 51 and a "northbound" track 52, both of which are to be used in directing cars to any of the classification tracks 1 through 36. There is a retarder 53 located at the inlet end of the first hump track 51. A mode switch 54 is provided for the control of retarder 53 between open, closed, and automatic control conditions. Retarder 53 also has a release speed selector switch 55 that is adjustable for release of cars from retarder 53 at high, medium, and low speeds. A scale 56 may be provided for use as a part of the control systems for other retarders in the yard. The second hump track 52, at its inlet end, is quite similar, and includes an inlet retarder with appropriate controls which may include a scale.

The hump tracks 51 and 52 are interconnected by a cross-over that includes two switches 41 and 43 interposed in southbound track 51 and two track switches 42 and 44 interposed in the northbound track 52. Track switch 41 in the southbound track 51 is connected by a first cross-over track 46 to track switch 44 in the northbound track 52. A second cross-over track 47 connects track switches 42 and 43 with the two tracks 46 and 47 intersecting at the cross-over 45. On console 40, each track switch is represented by an electrical mode selector switch that can be actuated to normal and reverse positions corresponding to the normal and reverse orientations of the track switch. With track switch 41 in its normal position, a car traveling along southbound track 51 continues its movement along that track to switch 43. When track switch 41 is in its reverse position, a car entering the yard along southbound track 51 is diverted to cross-over track 46 and moves along that track through switch 44 to the northbound hump track 52. The "normal" and "reverse" positions for the cross-over track switches 41-44 are indicated in FIG. 1.

Each of the mode switches on the console, representative of track switches 41-44, also has an "automatic" position. Because the present invention is concerned primarily with automated operation, each of the cross-over switches has been shown in the automatic position. Switch 19-20 is shown in its "normal" position; switch 19-21 is shown in its "reverse" position.

On track 51, beyond switch 43, there are two car retarders 57 and 58, each provided with an appropriate control switch for open, closed, and automatic operation. Beyond retarder 58, track 51 enters a track switch represented on console 40 by a mode selection switch 1-18. The mode switch for track switch 1-18, like the cross-over switches, has a normal position, a reverse position, and an automatic position. The normal and reverse positions provide manual control for actuating the track switch 1-18 to its normal and reverse switching conditions. The automatic position for the mode switch 1-18 permits automatic controls to actuate the track switch to either operating state.

Track switch 1-18, when in its normal position, directs cars from hump track 51 along a yard track leading to a track switch 1-13. Assuming all intervening track switches are in their normal positions, the car continues along a route through track switches 1-9, 1-4, and 1-2 to the first classification track in the yard, track 1. Along this route, the car encounters a retarder 59 that brakes the car to an appropriate speed so that the car is added to the contents of track 1 without undue damage to the car or its contents. Any car entering the yard along the southbound track 51 can also be diverted to any of the remaining tracks 2 through 18, after having passed the cross-over, depending upon the settings of the various track switches in the system. In each instance, automatically controlled car retarders are provided to brake the cars to appropriate levels commensurate with the lengths and other characteristics of the destination tracks. By use of the cross-over, the cars may be diverted to the tracks 19-36 in the other section of the yard.

Northbound track 52, beyond track switch 44, is similar to southbound track 51. It passes through a pair of retarders 61 and 62 to a track switch 19-36 which is the initial track switch in the second or "reverse" half of the yard. Track switch 19-36 and the subsequent track switches in this section of the classification yard, can be actuated to divert any car to any of destination tracks 19 through 36.

Control console 40 comprises a track selection apparatus 63, including a plurality of numerical selector switches, and a destination display 64. The track selection apparatus 63 comprises a group of pushbutton switches or other suitable devices for entering a series of route switching destination commands in a data storage unit. Display 64 has a capacity of four destinations; reading from left to right, the display 64 indicates that the next four cars will be routed to tracks 12, 6, 3 and 17, respectively. The present invention is not directly concerned with the automatic routing of cars to the individual destination tracks 1-36 in the classification yard. Rather, the invention relates to the controls for the cross-over comprising track switches 41-44. The route switching control for the yard, beyond the cross-over, can be quite conventional in construction. For example, the route switching control may be of the kind described and claimed in U.S. Pat. No. 3,480,773 to R. McCune and R. Wilson, issued Nov. 25, 1969, or that described and claimed in application Ser. No. 840,688 of R. Convey filed July 10, 1969. Consequently, the route switching data storage apparatus and the route switching controls for the yard tracks and switches are not described in detail herein.
Control of the basic mode of operation for the crossover, on panel 40, is exercised by the operator by means of two selector switches 71 and 72. Each of the selector switches has three positions, one for southbound humping operation, another for northbound humping operation, and a third for unlocked cross-over operation. The term "southbound humping," as used herein, refers to the automated classification of cars entering the yard on track 51 and destined for any of tracks 1–36. Similarly, the term "northbound humping" refers to classification of cars, under automatic control, entering the yard or track 52 and destined for any of the classification tracks. The term "unlocked cross-over" refers to operation with the cross-over track switches 41 through 44 subject to manual control.

As shown in FIG. 2, each of the selector switches 71 and 72 is a three pole switch. The individual pole 73, 75 and 77 of switch 71 are each connected in series with the corresponding pole 74, 76 or 78 of selector switch 72. To correlate the illustration of the switches in the schematic diagram of FIG. 2 with the representation in FIG. 1, it should be noted that closing of poles 73 and 74 is effected when switches 71 and 72 are thrown to their northbound positions. When the central poles 75 and 76 are closed, the selector switches are in the cross-over unlocked positions. For the southbound position of the two selector switches, it is poles 77 and 78 that are closed. The two selector switches 71 and 72 are not interlocked, but are independently operable.

One side each of the switch poles 73, 75 and 77 is connected to a first power line 81. Selector switch pole 74 is connected to a "request northbound humping" relay coil 83 that is returned to a second power line 82. Selector switch pole 76 is connected to the operating coil 84 of a "request unlocked cross-over" relay. The southbound selector switch pole 78 is connected to the coil of a "request southbound humping" relay 85, relay coils 84 and 85 both being returned to the power line 82.

Each of the three selector switch poles 74, 76 and 78 is also connected to a timer 86 that is utilized to actuate a time delay relay having an operating coil 7 that is connected to timer 87 timer. Thus, the northbound pole 74 of selector switch 72 is connected to timer 86 through two sets of normally closed relay contacts 84–1 and 85–1 from the request cross-over and request southbound relays 84 and 85. The unlock cross-over selector switch pole 76 is connected to timer 86 through the series combination of two sets of normally closed relay contacts 85–2 and 83–1 from the southbound and request northbound relays, respectively. Similarly, the southbound selector switch pole 78 is connected to timer 86 through the series combination of normally closed relay contacts 84–2 and 83–2 from the request cross-over and request northbound relays respectively.

The circuit of FIG. 2 includes a railroad alarm relay. The coil 87 of the railroad alarm relay has one terminal connected to the power line 82. The other terminal of coil 87 is connected to three sets of normally open relay contacts 89–1, 91–1, and 92–1, each of the three sets of contacts being returned to the power line 81.

The relay 89 of which contacts 89–1 are a part is a relay that is energized when a northbound humping operation is going forward. The contacts 92–1 are a part of a relay 92 that is energized during unlocked cross-over operations. The contacts 91–1 are a part of a relay 91 that is energized only when cars are being routed automatically for classification in a southbound humping operation.

The system of FIG. 2 further includes the coil 88 for a yard clear relay that is energized whenever the yard is clear or a humping operation is actually in progress. There are two energizing circuits for the yard clear relay coil 88. One of these circuits comprises four sets of normally closed relay contacts 132–1, 131–1, 133–1 and 123–1. The relays with which these contacts are associated are described more fully hereinafter. The alternate circuit comprises three sets of normally open relay contacts 87–1, 89–1 and 88–1. The contacts 87–1 are a part of the time delay relay 87. The contacts 89–1 are a part of the railroad alarm relay 89. The contacts 88–1 are holding contacts actuated by the yard clearance relay coil 88.

The control circuit shown in FIG. 2 also includes a coil 90 that is a part of a relay energized whenever a northbound humping operation is in progress. One terminal of coil 90 is connected to the power line 82. The other terminal is connected to the power line 81 through the series combination of five sets of normally open relay contacts. The first of these normally open contacts is the contact pair 88–5 of the yard clear relay 88. The remaining contacts 94–1, 141–1, 143–1 and 146–1 are incorporated in relays described more fully hereinafter. A southbound humping relay comprising an operating coil 91 is included in the system. One terminal of coil 91 is connected to the power line 82. The other terminal is connected to the power line 81 through the series combination of the normally open relay contacts 88–5 and four additional pairs of normally open relay contacts 93–1, 142–1, 144–1 and 145–1.

The next relay coil in FIG. 2 is coil 92, incorporated in a relay energized whenever the control system is actuated to permit manual control of transfer of cars between the two humping tracks 51 and 52 (FIG. 1) through the cross-over comprising track switches 41 through 44. The energizing circuit for coil 92, beginning at power line 81, includes a set of normally open contacts 87–2 of the time delay relay 87. In series therewith, the circuit comprises a pair of normally open contacts 84–3 from the request unlocked cross-over relay 84. In the same circuit there is a pair of normally closed contacts 123–2 incorporated in an occupancy detector circuit for the cross-over and a pair of normally closed contacts 133–2 in a relay utilized to indicate the state of route storage information in the system. A holding circuit for the coil 92 of the unlock cross-over relay is provided by the normally open relay contacts 92–2.

The time delay relay contacts 87–2 are also connected in series with a pair of normally open contacts 85–3 from the request southbound relay 85 in the energizing circuit for a delay southbound relay coil 93. A similar circuit is provided for a delay northbound relay coil 94, which is connected to a pair of normally open contacts 83–3 from the request northbound relay 83, the circuit being completed through the time delay relay contacts 87–2.
A cross-over alarm lamp 116 is included in the circuit of Fig. 2. Lamp 116 is connected to power line 82 and to the movable contact of a set of relay contacts 92-7 of the unlock cross-over relay 92. The normally open contact of set 92-7 is connected to power line 81. The normally closed contact of set 92-7 is connected to a pair of normally closed contacts 89-2 of the railroad alarm relay 89, in turn connected to a conventional flasher circuit 115 energized from power line 81. Lamp 116 (Figs. 1 and 2) flashes continuously whenever the cross-over comprising track switches 41 through 44 is not properly conditioned for controlled operation, as discussed further hereinafter.

The continuation of the control circuit illustrated in Fig. 3 includes the switch throw and other control circuits 95 for actuating track switch 43 and the control circuits 96 for actuating of the track switch 44 between normal and reverse operating conditions. The switch command circuit 97 for actuating control unit 95 to throw track switch 43 to its reverse position includes, in series, a pair of normally open contacts 103-1 of a switch automated relay described hereinafter, a pair of normally open contacts 94-2 of the northbound delay relay 94, and a pair of normally open contacts 88-2 of the yard clear relay 88. The circuit 98 for supplying an actuating signal to the control unit 95 to actuate track switch 43 to its normal position comprises a pair of normally open contacts 103-2 from the aforementioned automated condition relay, a pair of normally open contacts 93-2 from the southbound delay relay 93, and the yard clear relay contacts 88-2. The normal command circuit 99 for actuating control unit 96 to throw track switch 44 to its normal position comprises a pair of normally open contacts 104-1 from a relay that indicates switch 44 is in its automatic mode of operation, in series with the contacts 94-2, and the contacts 88-2. The similar reverse throw command circuit 100 includes, in series, the relay contacts 104-2, 93-2, and 88-2.

The operating coil 103 for the relay that indicates track switch 43 is conditioned for automatic controlled operation has one terminal connected to the power line 82 and the other terminal connected to the "automatic" pole of the mode selection switch for controlling track switch 43, identified in Fig. 3 as the pole switch 43A. The "automatic" pole of switch 43A is connected to the other power line 81 through the normally closed contacts 118A of one pole of a double-pole double-throw presence detector switch 118 that is actuated in response to the presence of a car in the section of the track encompassing track switch 1-18 (Fig. 1). The normally closed contact of presence detector switch pole 118A is also connected to a pair of normally open contacts 92-3 of the unlock cross-over relay 92, the contacts 92-3 being connected to both the "reverse" and "normal" poles of the mode switch 43A (Fig. 3). Each of the reverse and normal poles of the mode switch 43A is connected to control unit 95 to provide for manual actuation of the track switch 43 as described more fully hereinafter.

The operating circuit for the relay 104 that indicates conditioning of track switch 44 for automatic operation is connected in a similar circuit. Thus, relay coil 104 is connected to power line 82 and to the "automatic" pole of a three-position mode switch 44A. The automatic pole of the mode switch 44A is connected to the power line 81 through the normally closed contacts of the second pole 118B of the presence detector switch 118 for track switch 1-18. A pair of normally open contacts 92-4 of the unlock cross-over relay 92 are also connected to the normally closed contact of pole 118B of the presence detector switch 118, affording throw command circuits for the control unit 96 through the reverse and normal poles of the mode switch 44A.

The switch actuation circuits for track switch 41 are generally illustrated, in Fig. 3, as the control unit 105. The control unit 105 has two inputs derived from the normal and reverse poles of a three position mode switch 41A for determining the operational mode of track switch 41. The "normal" and "reverse" sections of mode section 41A are connected to the power line 81 through the normally closed contacts of a first pole 119A of a double-pole double-throw presence detector switch 119. The switch throw circuits 105 are also provided with an input from the "automatic" pole of mode switch 41A, which is directly connected to power line 81. The automatic pole of mode switch 41A is also connected in an energizing circuit for a normal command relay coil 121 for actuating track switch 41 to its normal position through operation of the control unit 105. This circuit includes, in series, a pair of normally open contacts 88-3 of the yard clear relay 88 and a pair of normally open contacts 94-3 from the northbound delay relay 94.

The "normal" command input circuit to control unit 105 also comprises a pair of normally open contacts 121-1, a part of the normal command relay 121, connected in parallel with the "normal" contacts of the mode switch 41A. A part of the control unit 105 is shown in detail in Fig. 3 and comprises three sets of normally open contacts 91-2, 92-5, and 121-2 all connected in parallel with each other to afford enabling circuits for track switch operations as described more fully hereinafter.

The part of the control system shown in Fig. 3 includes a control unit 106 for actuating track switch 42 between its normal and reverse positions. The track switch control unit 106 has two inputs connected to the "normal" and "reverse" poles of a mode switch 42A associated with track switch 42 in the cross-over for the yard. The normal and reverse poles of mode switch 42A are each connected to the power line 81 through the normally closed contacts of a second pole 119B of the presence detector switch 119. The "automatic" pole of mode switch 42A is also connected to power line 81 and is connected in an energizing circuit for a "normal" command relay coil 122 for track switch 42. The energizing circuit for relay 122 includes, in series, a pair of normally open contacts 88-4 of the yard clear relay and a pair of normally open contacts 93-3 from the southbound delay relay 93.

The "normal" command input circuit for control unit 106 also comprises a pair of normally open contacts 122-1 of the command relay 122 which are connected in parallel with the "normal" pole of mode switch 42A. As in the case of the control unit 105, the control unit 106 is provided with auxiliary control contacts 92-6, 90-2, and 122-2 to afford enabling circuits as described more fully hereinafter.
The normally open contact of presence detector switch pole 118A is connected to a blocking diode 107 and the normally open contact of the presence detector switch pole 118B is connected to a blocking diode 108. Similarly, the normally open contacts of poles 119A and 119B of presence detector switch 119 are connected, respectively, to two blocking diodes 109 and 110. A cross-over presence detector switch 120 is included in the system and has its normally open contact connected to a blocking diode 111. The diodes 107 through 111 are all connected to one terminal of a coil 123 for a cross-over occupancy detector relay. The relay comprising coil 123 is energized whenever there is a vehicle in any part of the cross-over portion of the yard, including track switches 41 through 44 and cross-over tracks 46 and 47.

The part of the control system that is shown in FIG. 4 includes the operating coil 131 for a normal section occupancy detection relay. The “normal” section of the yard is defined as the section including classification tracks 1 through 18. The energizing circuit for coil 131 includes a presence detector switch in each of the control units for the track switches in the normal section of the yard, starting with track switch 1—2 and including all of the track switches through track switch 1—18 (see FIG. 1). Thus, coil 131 is energized whenever there is a car at any place in the yard from track switch 1—18 through any of the final tier of track switches such as track switch 1—2.

A similar control is provided for energization of the operating coil 132 of a “reverse” section occupancy detector relay (FIG. 4). Thus, the energizing circuit for coil 132 includes a presence detector switch in each of the route switching control units for the track switches 19—36 through 35—36.

The control system, in the portion shown in FIG. 4, includes three switch position repeater relays 142, 146 and 145 that are energized in accordance with the actual positions of track switches 42 and 44 as determined by suitable detector apparatus 148. Thus, the coil 142 is energized whenever switch 42 is in its “normal” position, directing cars along track 52 to track switch 44 (FIG. 1). Relay coil 146 (FIG. 4) is energized whenever track switch 44 is in its “normal” position, guiding cars along track 52 to track switch 19—36 (FIG. 1). Relay coil 145 (FIG. 4) is energized whenever track switch 44 is in its “reverse” position, routing cars from track 46 onto track 52 (FIG. 1). For the “normal” section of the yard, there is a similar group of position repeater relays 141, 143 and 144, actuated by detector apparatus 149 (FIG. 4). Thus, relay 141 is energized whenever track switch 41 is in its “normal” position, relay 143 is energized whenever track switch 43 is in its “reverse” position, and relay 144 is energized whenever track switch 44 is in its “normal” position.

An additional control relay, comprising the coil 133, is provided in the circuit of FIG. 4, actuated by the route storage unit 151 in which routing commands are stored during automated switching operations. Coil 133 is energized whenever one or more route commands have been stored in the system and are shown in display 64 (FIG. 1). The energizing circuits for the route data entry controls 63, also shown in FIG. 4, are effected through storage unit 151. These energizing circuits include a pair of normally open contacts 90—3 of the northbound humping relay 90 and a pair of normally open contacts 91—3 from the southbound humping relay 91, in parallel with each other. Thus, new route data can be entered in the system only when it is conditioned for either northbound or southbound automated operation.

As shown in FIG. 3, the route storage unit 151 is connected to the control unit 105 for track switch 41, through two sets of normally open contacts 91—4 and 91—5 of the southbound humping relay 91. Similarly, the route data storage unit 151 is connected to the control unit 106 for track switch 42 by two sets of normally open contacts 90—4 and 90—5 of the northbound humping relay 90. These circuits provide for the actuation of track switches 41 and 42 under automatic route switching control as described more fully hereinafter.

A. SOUTHBOUND CLASSIFICATION OPERATION

When the system operator desires to operate the system in the “southbound” mode, with cars entering the yard along the “southbound” track 51, he throws both of the selector switches 71 and 72 to their southbound positions (FIGS. 1 and 2). This completes an operating circuit for the request southbound relay coil 85 and energizes that relay. At the same time, the timer 86 is energized through a circuit comprising the contacts 77 and 78 of switches 71 and 72 and the relay contacts 84—2 and 83—2, which remain closed.

The timer 86 comprises a conventional adjustable time delay device having a delay interval range of the order of a few seconds to a few minutes. For example, the timer may comprise a commercially available Potter and Brumfield timer Model CDDL21—30003 having an adjustable delay interval of 1.8 to 180 seconds. Upon completion of the time delay interval for which timer 86 is set, the time delay relay coil 87 is energized. The time delay relay coil 87 is energized only if the energizing circuit to timer 86 is maintained continuously; any interruption in the energizing circuit for timer 86 causes the timer to reset and hence causes the time delay relay 87 to drop out. The minimum reset time is 60 milliseconds. Accordingly, the three request relays 83, 84 and 85 are made slow release relays, as by connecting a capacitor across the operating coil in each instance. The contacts de-energized. As a consequence, with the yard clear and with the storage of route switching data clear, the relay contacts 131—1, 132—1, 133—1 and 123—1 remain closed and the yard clear relay coil 88 is energized. When the yard clear relay 88 picks up, the yard clearance check is completed and the control begins a period for automatic throwing of the track switches for control of the cross-over.

In some systems, it may not be deemed necessary to be certain that the entire yard is clear before initiating a new mode of classification operation. Under such circumstances, the yard occupancy detectors 131 and 132 can be eliminated, together with the data storage detector relay 133. However, the cross-over must be clear; the cross-over occupancy detector relay 123 is essential to safe operation.

The operator must set mode switch 42A (FIG. 3) for track switch 42 in its automatic position, since automatic southbound humping is desired. With the yard clear relay 88 energized, and the delay southbound
relay 93 having previously been energized, the contacts 88–4 and 93–3 are closed, completing an energizing circuit for the relay coil 122 that establishes a “normal” command signal for track switch 42. Energization of coil 122 results in the closing of relay contacts 122–1 and 122–2, completing an energizing circuit to control unit 106 for track switch 42 that throws track switch 42 to its normal position if the track switch is not already in that position. Of course, these operations actuating track switch 42 are completed only if there is no vehicle occupying the track switch, indicated by the fact that the request relays 83, 84 and 85 that connect the selector switches 71 and 72 in the energizing circuit of timer 86 are so arranged that any change in the setting of either selector switch provides more than 60 milliseconds reset time. As a consequence, any actuation of either of the selector switches 71 and 72, however slight, causes timer 86 to reset, drops out time delay relay 87, and initiates the indeterminate state of operation described in detail hereinafter.

With the selector switches 71 and 72 both set for southbound operation, and after the time delay relay 87 has been energized, contacts 87–2 and 85–3 close, energizing the southbound delay relay coil 93. This marks the end of the initial time delay period for southbound humping operation and the beginning of a period for checking the yard to make sure that it is clear of vehicles before automatic operation is initiated.

If there are no vehicles in the cross-over portion of the yard, the presence detector switches 118, 119 and 120 are unactuated. As a consequence, the cross-over occupancy relay 123 remains de-energized. If all of the track switches in the “normal” section of the yard, comprising track switches 1–18 through 1–2, are clear, the normal section occupancy relay coil 131 (FIG. 4) remains de-energized. Similarly, if all of the track switches 19–36 through 35–36 in the “reverse” section of the yard are clear of vehicles, the reverse section occupancy relay coil 132 remains de-energized. At the same time, if the storage unit 151 for the route switching system is clear, the data storage detector relay 133 remains presence detector switch 119B remains closed.

With the presence detector switch 118 remaining unactuated, and with mode switch 43A in its automatic position as shown in FIG. 3, the relay coil 103 for automatic operation of track switch 43 is energized. Similarly, the coil 104 for the relay entailing automatic operation of switch 44 is energized, mode switch 44A being in its automatic position and presence detector switch 118 being unactuated.

Because the yard clear relay 88 has been energized as described above, and the southbound delay relay 93 has also been energized, contacts 88–2 and 93–2 are closed (FIG. 3). With the relay coil 103 actuated, the contacts 103–2 are closed and supplying an actuating signal on line 98 to the control unit 95 for track switch 43, throwing track switch 43 to its “normal” position. Similarly, the contacts 104–2 having closed, an actuating signal is supplied to the control unit 96 for track switch 44 to actuate that track switch to its “reverse” position. Thus, the track switch 42 is established in its normal position, the track switch 43 is its normal position, and the track switch 44 is in its reverse position. As a consequence, the position detector relays 142, 144 and 145 (FIG. 4) are all energized. This closes contacts 142–1, 144–1 and 145–1 in series with the operating coil 91 of the southbound humping relay (FIG. 2). The yard clear relay contacts 88–5 and the southbound delay contacts 93–1 have previously been closed, so that coil 91 is energized and the southbound humping relay is actuated. The energization of relay 91 marks the end of the automatic throwing period for the track switches and the beginning of the period of actual southbound humping operations. It should be noted that provision may be made for a separate checking circuit in the energizing circuits for the relays 90, 91 and 92 if desired, to defer operation of those relays pending a check of other yard conditions (cars too far advanced on hump, hump signals to train crew inoperative or incorrectly actuated, etc.).

With classification operations now in progress, the southbound humping mode, several operations take place in the control system. The actuation of relay 91 closes contacts 91–1 (FIG. 2) and energizes the railroad alarm relay 89. The energization of this relay opens contacts 89–2 in the operating circuit for the cross-over alarm lamp 116. Lamp 116 ceases its flashing, so that the operator knows that humping operations can go forward.

The operator can now enter new route switching information into the system by means of the route data entry controls 63 (FIGS. 1 and 4). The energization of the southbound humping relay 91 closes the contacts 91–3 in the operating circuit for the track entry pushbuttons and other controls 63 (FIG. 4) and allows the entry of a new series of routes into the route switching system.

The energization of the southbound humping relay 91 also closes contacts 91–4 and 91–5 in the input circuit from the route storage unit 151 to the control unit 105 for track switch 41 (FIG. 3). Closing of these contacts provides for the transmission of throw command signals to the control unit 105 to actuate track switch 41 between its normal and reverse positions, as required, during the humping operation, depending on whether cars are being routed to the “normal” section of the yard comprising tracks 1 through 18 or to the “reverse” section of the yard comprising tracks 19 through 36. The route storage unit 151 is a part of the route switching control for the yard and hence is not shown in detail. The contacts 91–2 connected in the external circuit for control unit 105 also close, affording an enabling circuit for the control unit 105 for completion of the throwing circuits for track switch 41 as required.

B. NORTHBOUND CLASSIFICATION OPERATION

When the system operator desires to use the northbound track 52 as the entrance track for automatically controlled classification operations, he actuates both of the selector switches 71 and 72 (FIGS. 1 and 2) to their respective northbound positions. As soon as either one of the selector switches is thrown, timer 86 is de-energized and time delay relay 87 drops out. This effectively inhibits continuing operation in the previous state, whether southbound humping or manual operation with the cross-over unlocked, and initiates a new sequence of operations to establish the system in its northbound humping condition.
After the time delay interval established by timer 86 has elapsed, the time delay relay 87 is again energized (FIG. 2). The request northbound relay 83 has previously been energized by actuation of selector switches 71 and 72. As a consequence, contacts 87-2 and 83-3 are closed, energizing the northbound delay relay 94. This completes the delay period for the beginning of a new operational condition and initiates the period for checking or yard clearance.

As before, if the track switches are all clear, the relays 123 (FIG. 3), 131 and 132 (FIG. 4) all remain de-energized. If there are still some cars or other vehicles present in any of the track switches, the establishment of the northbound humping operation is deferred until they have been cleared by movement of the cars into the classification tracks beyond the track switches or by movement out of the yard on tracks 51 and 52. This also entails the clearing of previously stored route switching information so that relay 133 (FIG. 4) is de-energized when the yard is actually cleared. Accordingly, with the yard cleared contacts 132-1, 131-1, 133-1 and 123-1 are closed and the yard clear relay 88 is energized (FIG. 2). This completes the yard clearance check and begins the automatic switch throwing interval in establishment of the northbound humping operation.

The energization of the yard clear relay 88 closes its contacts 88-3 (FIG. 3). Since the northbound delay relay 94 has previously been energized, contacts 94-3 are closed and a complete energizing circuit is available for the relay 121 used to establish switch 41 in its normal position. The energization of relay 121 closes contacts 121-1 and supplies a command signal to control unit 105 to actuate track switch 41 to its normal position. Track switch 41 remains in this position as long as northbound humping is continued. As before, the throwing of track switch 41 can be effected only if there is no car present in the track switch, as determined by the presence detector switch 119A.

With both of the mode switches 43A and 44A in the automatic position, as required for northbound humping operations under automatic control, the two relays 103 and 104 (FIG. 3) are energized. Consequently, their contacts 103-1 and 104-1 are closed. The contacts 94-2 of the northbound delay relay and the contacts 88-2 of the yard clear relay have previously been closed, so that both lines 97 and 99 (FIG. 3) are energized, supplying a reverse throw command signal to control unit 95 for track switch 43 and a normal throw command signal to control unit 96 for track switch 44. This conditions the two track switches 43 and 44 as required for humping operations using the northbound lead-in track 52.

The switch position detector circuits (FIG. 4) are now energized in accordance with the positions of track switches 41, 43 and 44. Thus, relay 141 for track switch 41 normal, relay 143 for track switch 43 reverse, and relay 146 for track switch 44 normal are all energized (FIG. 4). This completes an operating circuit to the humping northbound relay 90 (FIG. 2) through the circuit comprising the yard clear contacts 88-5, the delay northbound contacts 94-1, and the position relay contacts 141-1, 143-1 and 146-1. Energization of relay 90 ends the automatic track switch throw period and permits the initiation of northbound humping operations.

With northbound humping operations initiated, railroad alarm relay 89 is energized through the northbound humping relay contacts 90-1 (FIG. 2). This opens contacts 89-2 and interrupts the flashing operation of the cross-over alarm 116. The energization of the railroad alarm relay 89 also closes the contacts 89-1 to complete a holding circuit for the yard clearance relay 88 to keep that relay energized even though any of the occupancy detector relays may be energized as cars pass into and through the yard.

With the northbound humping relay 90 energized, contacts 90-3 (FIG. 4) are also closed, energizing the track entry controls 63 to allow entry of route switching information into the route switching portion of the system. As shown in FIG. 3, the contacts 90-2 are closed, completing an enabling circuit for the control unit 106 for track switch 42 and permitting actuation of the track switch 42 in response to signals from the route switching data storage unit 151. These signals are supplied from the route storage unit 151 through contacts 90-4 and 90-5, which are now closed. It should be noted that the connections from the route storage unit 151 to control unit 106 are inverted as compared with the connections from storage unit 151 to track switch control unit 105, permitting use of a single route storage unit to control either of the track switches 41 and 42 depending upon whether the operation is proceeding in the northbound humping mode or the southbound humping mode.

C. UNLOCKED CROSS-OVER (MANUAL) OPERATION

In the unlocked cross-over operating state, the control system provided for manual operation of the cross-over switches 41, 42, 43 and 44. This operating condition is initiated by the operator throwing both of the selector switches 71 and 72 (FIGS. 1 and 2) to their unlocked cross-over positions. When this is done, the energization of timer 86 (FIG. 2) is momentarily interrupted and then restored, and the request cross-over relay 84 is energized. This initiates the same time delay as for either northbound or southbound humping, completed upon energization of the time delay relay 87.

When the time delay relay 87 picks up, its contacts 87-2 close. Contacts 84-3 of the request cross-over relay 84 are already closed. Assuming that the cross-over is unoccupied by any vehicle, the cross-over occupancy relay 123 (FIG. 3) is de-energized so that contacts 123-2 (FIG. 2) remain closed. If there is no remaining route storage information in the display, indicating that no car is traversing the yard toward a destination track, the data storage relay 133 (FIG. 4) is de-energized so that the contacts 133-2 (FIG. 2) remain closed. Under these circumstances, the unlock cross-over relay 92 is energized, closing its own contacts 92-2 to establish a holding circuit that will maintain the relay energized even though cars are subsequently moved through the cross-over and into the yard.

The energization of the unlock cross-over relay 92 actuates the relay contacts 92-7 (FIG. 2) from the position shown in the drawing to their alternate position, establishing a direct connection from the cross-over alarm 116 to the power line 81. Accordingly, the cross-over alarm 116 is energized on a continuous ba-
sis, instead of flashing, signalling the operator that the cross-over has been unlocked and can be controlled manually. Contacts 92-1 also close, in the energizing circuit for the railroad alarm relay 89 (FIG. 2). This completes a holding circuit for the yard clearance relay 88 by closing contacts 89-1.

Energization of the unlocked cross-over relay 92 also closes the contacts 92-3 that are connected to the mode switch 43A (FIG. 3). Now, when the operator actuates switch 43A to either its normal or reverse position, appropriate command signals are supplied to control unit 95 to actuate track switch 43. Similarly, contacts 92-4 are closed, allowing manual actuation of the control unit 96 for track switch 44 by means of mode switch 44A (FIG. 3). In addition, contacts 92-5 are closed, completing an enabling circuit for control unit 105 for track switch 41; track switch 41 can now be manually thrown by operation of mode switch 41A in the same manner, the closing of contacts 92-6 conditions control unit 106 for manual actuation of track switch 42 by means of mode switch 42A. It is thus seen that, with the control system in the unlocked cross-over condition, any and all switches can be actuated manually to control the movement of cars into the yard when automatic switching is not desired.

INHIBITED OPERATIONAL STATE

There are several operating conditions for the system in which it is necessary and desirable to preclude the transfer of cars through the cross-over and into the classification yard and particularly to preclude the throwing of the cross-over track switches 41 through 44. This same inhibited operational condition provides for the prevention of entry of route switching information. As long as the inhibited operational state is maintained, the cross-over alarm indicator 116 flashes intermittently to caution the operator that humping should not be attempted. Other warning devices, such as signals on the tracks 51 and 52 ahead of the cross-over, may also be actuated.

The first situation that can cause the control system to assume this inhibited operational state occurs when the two selector switches 71 and 72 (FIGS. 1 and 2) are not in corresponding positions. Under these circumstances, none of the three request relays 83, 84 and 85 is energized and there is no complete energizing circuit for timer 86 (FIG. 2). Accordingly, the time delay relay 87 cannot be energized and the relays 90, 91, 92, 93 and 94 all remain deenergized. As a consequence, the railroad alarm relay 89 cannot be energized. The cross-over alarm indicator 116 remains connected in circuit with the flasher 115 and gives a continuous intermittent signal to the operator that humping should not be attempted.

A similar situation obtains when the selector switches 71 and 72 are both thrown to either the northbound or southbound position but the yard has not been cleared so that the yard clear relay 88 cannot be energized. For example, a change from some other operating condition to the southbound humping condition may be attempted while a car is still present in some part of the cross-over comprising track switches 41 through 44 and the connecting tracks 46 and 47. Under these circumstances, the cross-over occupancy relay 123 (FIG. 3) is energized through one of the presence detector switches 118, 119 or 120. This opens the contacts 123-1 in series with the yard clearance relay 88 (FIG. 2). Under these conditions the northbound and southbound humping relays 90 and 91 cannot be energized because the contacts 88-5 remain open. The railroad alarm relay 89 cannot be energized and the warning signal, the flashing of cross-over alarm 116, continues.

It may also happen that either the northbound or southbound humping state is requested but one of the cross-over switches fails to throw to the requisite condition for that state. This condition is reflected in a failure to energize the required combination of switch position relays 141 through 146 (FIG. A). Under these circumstances, the required humping relay 90 or 91 (FIG. 2) is not energized and the inhibited operational state is maintained.

The inhibited operational state also obtains when the selector switches 71 and 72 are actuated to their unlock cross-over positions but a vehicle is present some place in the cross-over as indicated by energization of the cross-over occupancy relay 123. When this occurs, the contacts 123-2 in series with the unlock cross-over relay 92 are open and that relay cannot be energized. Under these circumstances, the contacts 92-1 in series with the railroad alarm relay 89 remain open; moreover, the yard clear relay 88 cannot be energized. The alarm indicator 116 continues to flash and signals the operator that a humping operation should not go forward.

The same operational conditions obtain when route commands remain in the storage unit, from previous operations, so that the relay 133 (FIG. 4) is energized. This prevents completion of the sequence of operations necessary to achieve the unlocked cross-over operating condition, since the contacts 133-2 in series with the unlock cross-over relay 92 are open and the contacts 133-1 in series with the yard clear relay 88 are open. The presence of cars in the yard during changeover, indicated by the energization of the occupancy detector relays 131 and 132, produces the same result.

CONCLUSION

From the foregoing description, it will be apparent that the cross-over control of FIGS. 1-4 provides a selector means, comprising the two selector switches 71 and 72 and the three request relays 83, 84 and 85, that actuates the control to any one of the three following conditions:

A. automatic route switching using the southbound inlet track 51,
B. automatic route switching using the northbound inlet track 52, and
C. manual control of the cross-over track switches 41 through 44 (the unlocked cross-over condition).

The southbound delay relay 93, in conjunction with the control units 95 and 96 for track switches 43 and 44, affords a first track switch control means that is actuated when the selector is in condition A to throw the downstream track switch 43 in the southbound track to normal condition and to throw the downstream track switch 44 in the northbound track 52 to reverse position. The track switches 43 and 44 are maintained in these positions, by the same control, as long as southbound humping (condition A) is maintained. A
second switch control means, comprising the contacts 94-2 of the northbound delay relay 94 in combination with the contacts 95 and 96, affords the same operation with respect to the downstream cross-over track switches, but with the track switch positions reversed, for northbound humping (condition B).

The time delay means of the control system, comprising the timer 86 and the relays 87, 93 and 94, inhibits actuation of the switch position control means for a predetermined time interval, the time delay of the timer 86, whenever the selector means, selector switches 71 and 72, is actuated from one operating condition to another. For either of the operating conditions A and B, comprising southbound humping and northbound humping, the contacts of the relays 90 and 91 connect the route switching data storage unit 151 to the two upstream cross-over track switches 41 and 42, through controls 105 and 106, to provide for automated control of the upstream track switches. The inversion of the connections that the relay contacts afford between storage unit 151 and controls 105 and 106 makes it possible to use the route storage data without change regardless of whether the southbound or the northbound inlet track is being used. The occupancy clearance means comprising the cross-over occupancy detector relay 123, the yard clearance relay 88, and the humping relays 90 and 91 is effective to inhibit actuation of both the switch control means for the downstream track switches and the coupling means for actuation of the upstream track switches whenever the cross-over is occupied.

Additional safety is provided by the track switch position detectors 141 through 146, which inhibit automated control of the upstream cross-over track switches 41 and 42 until the downstream switches 43 and 44 have reached the required position for the operating condition currently determined by the selector switches 71 and 72. The alarm, including the relays 89 and 92 and the lamp 116, effectively warns the system operator not to initiate a new classification operation whenever the selector switches 71 and 72 are set for either northbound or southbound humping but actuation of the cross-over track switches has been inhibited by the time delay means, the occupancy clearance means, or the track switch position detector means of the overall control system.

Additional inhibition on operation is provided by the relay contacts connected in the enabling circuits for both of the track switch control units 105 and 106. Whenever the control system is not fully established in either the northbound humping condition or the unlocked cross-over condition (conditions B and C) the upstream track switch 41 in the southbound inlet track cannot be thrown because none of the contacts 91-2, 92-5, and 121-2 is closed. The external relay contacts in the enabling circuit for the control unit of a track switch 42 perform the same inhibition function with respect to that track switch whenever the control system is not fully established in either the southbound or the unlocked cross-over condition (conditions A and C).

Although electromagnetic relays have been shown and described as the principal operating elements in the control system, it will be recognized that other control elements, particularly solid state gates, flip-flop cir-
2. A cross-over control for an automated railroad classification yard, according to claim 1, and further comprising:

track switch position detector means for detecting the positions of said downstream cross-over track switches and for inhibiting actuation of said coupling means until said downstream cross-over switches have reached the required positions for the operating condition currently determined by said selector means.

3. A cross-over control for an automated railroad classification yard according to claim 2, and further comprising:

alarm means for warning an operator not to initiate a new classification operation whenever the selector has been set for either condition A or B but actuation of any of said first track switch control means, said second track switch control means, and said coupling means is inhibited by any of said time delay means, said occupancy clearance means and said track switch position detector means.

4. A cross-over control for an automated railroad classification yard according to claim 3 in which said alarm means comprises a visual warning device that is quiescent whenever the control is established in either of operating conditions A and B, that is continuously actuated whenever the control is established in operating condition C, and that is intermittently actuated whenever the control is in any other operating condition.

5. A cross-over control for an automated railroad classification yard according to claim 1 in which said coupling means includes a first pair of coupling circuits from said storage means to said upstream track switch in said first inlet track and a second pair of coupling circuits from said storage means to said upstream track switch in said second inlet track, and in which said first pair of coupling circuits is inverted with respect to said second pair to allow control of both upstream track switches from a single stage of data storage.

6. A cross-over control for an automated railroad classification yard according to claim 1, and further comprising detector means for detecting the presence of route switching data in said data store and for inhibiting actuation of said switch control means and said coupling means until such data has been cleared.

7. A cross-over control for an automated railroad classification yard according to claim 1 and further comprising:

first inhibiting means to inhibit throwing of said upstream track switch in said first inlet track whenever the control is not fully established in either of the operating conditions B and C; and second inhibiting means to inhibit throwing of said upstream track switch in said second inlet track whenever the control is not fully established in either of the operating conditions A and C.

8. A cross-over control for an automated railroad classification yard according to claim 1, in which said first track switch control means throws the upstream cross-over track switch in said second inlet track and maintains it in normal position, and in which said second track switch control means throws the upstream cross-over track switch in said first inlet track and maintains it in normal position.

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