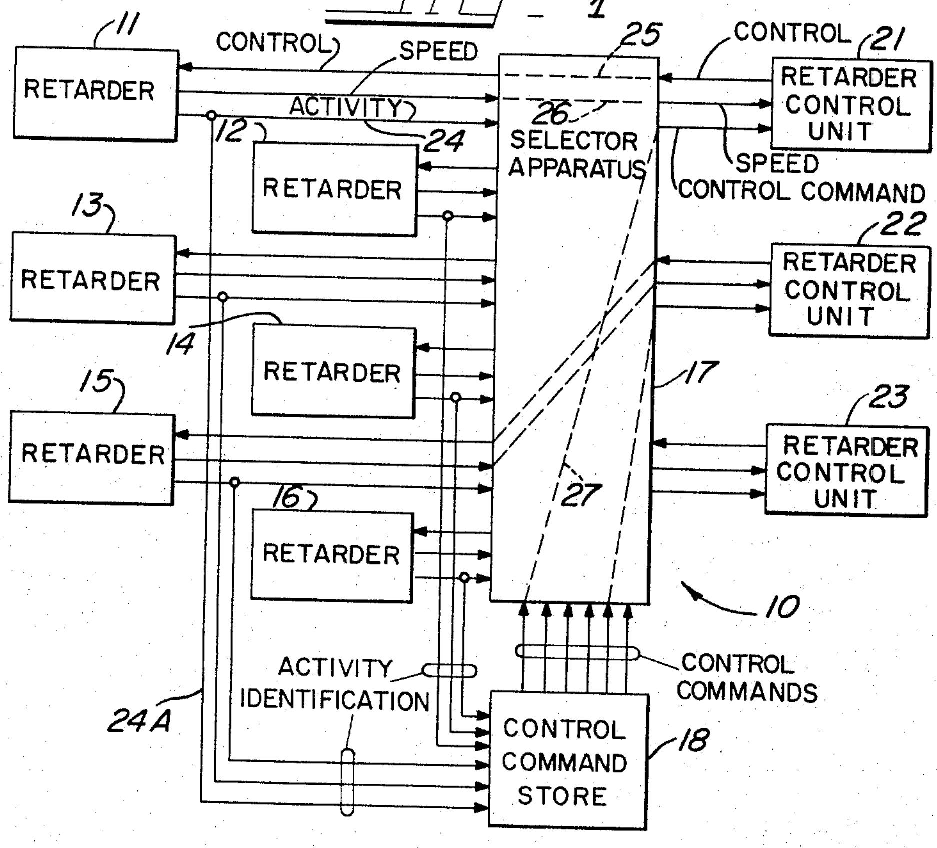
Dec. 3, 1968 R. B. McCUNE ETAL 3,413,930
RAILROAD RETARDER CONTROL SYSTEMS
Filed Feb. 21, 1966 4 Sheets-Sheet 1

FIG. 1



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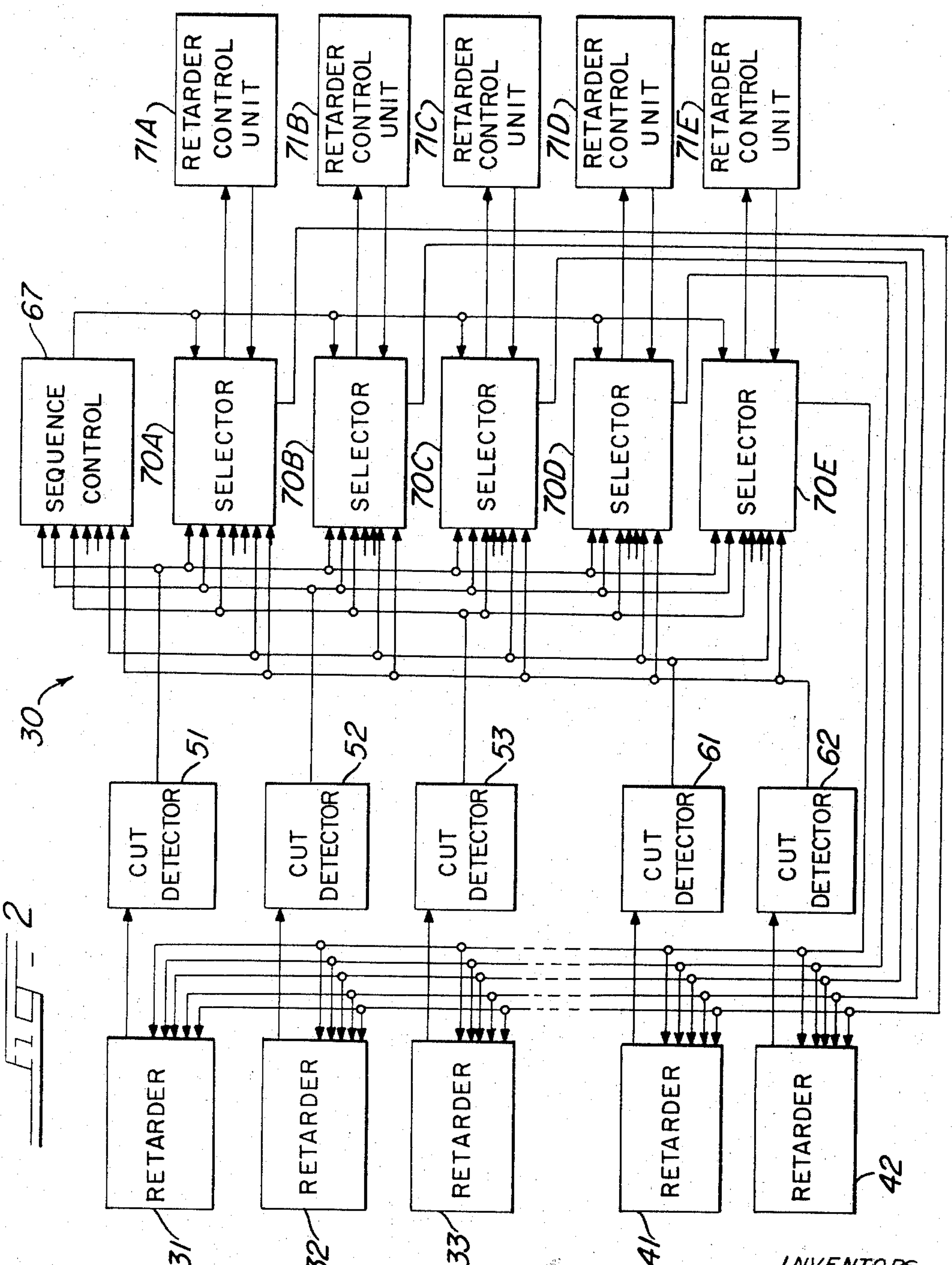

FIG-2

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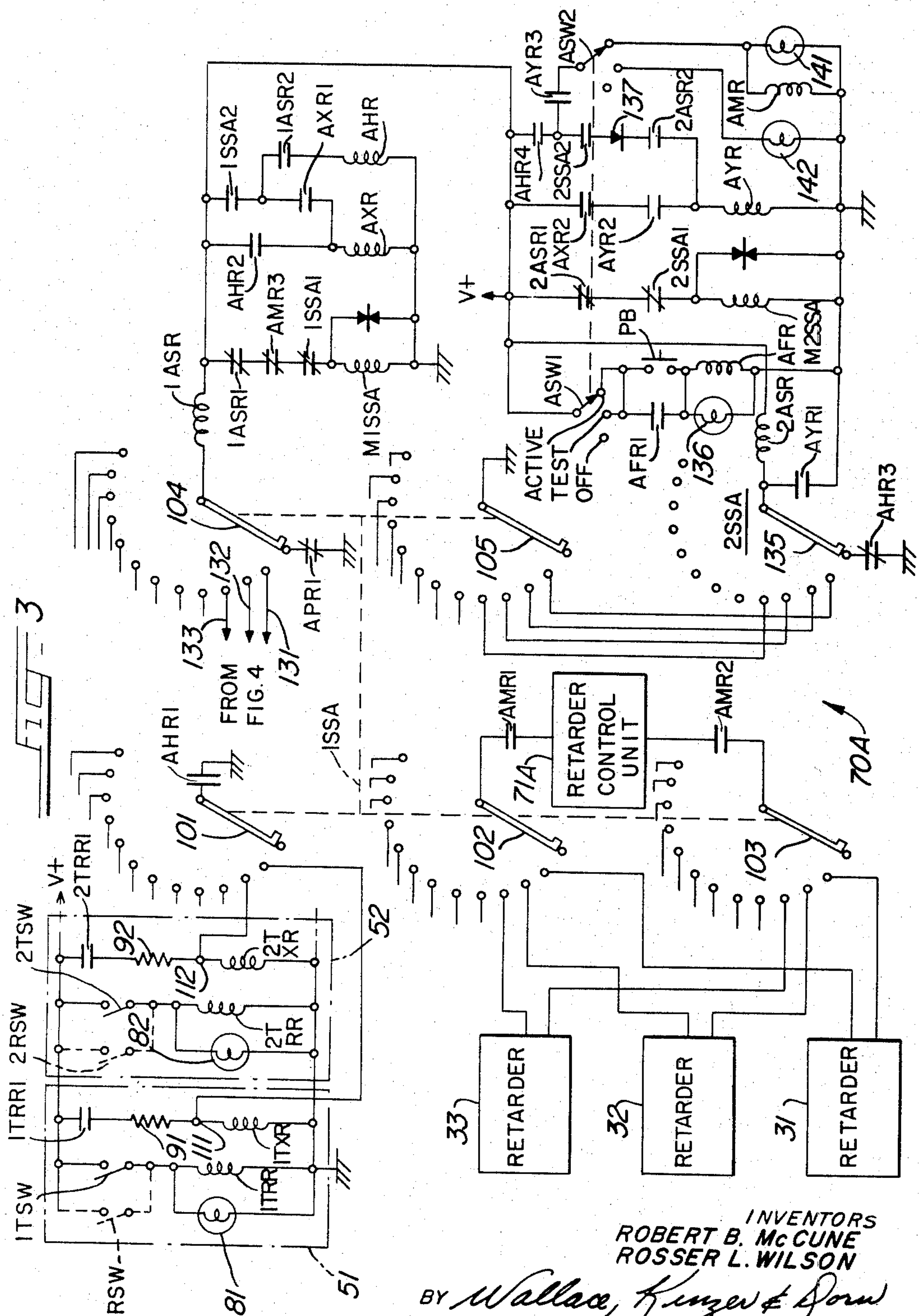
FIG. 3



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RAILROAD RETARDER CONTROL SYSTEMS

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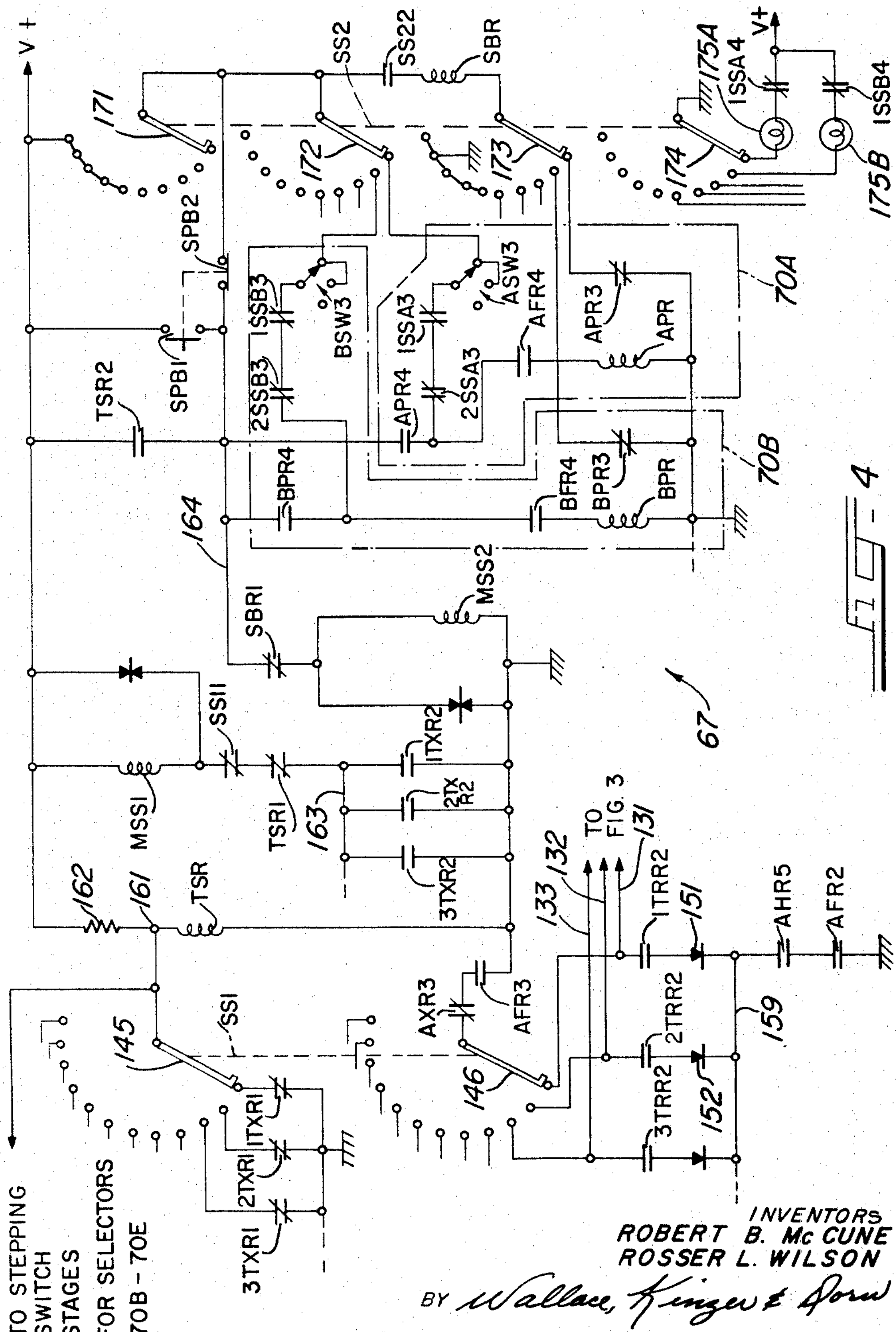

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RAILROAD RETARDER CONTROL SYSTEMS

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9 Claims. (Cl. 104—26)

ABSTRACT OF THE DISCLOSURE

A selective control system for the car retarders in a railroad freight classification yard, in which a single control unit may serve a substantial number of different retarders. The control system comprises several independent retarder pressure control units, the number of control units being substantially smaller than the number of car retarders in the yard, but each control unit being capable of controlling the operation of any one of the retarders. A selector apparatus is interposed between the control units and the car retarders and is used to complete operating connections, individually and selectively, between any one of the control units and any one of the car retarders. The system further includes sequence control means that determines which control unit is to be connected to an individual retarder when control of that retarder is required.

This invention relates to a new and improved selective control system for railroad retarders and more particularly to an automatic selector system for controlling a substantial number of car retarders, located in one or more classification yards, from a central location.

Increasing emphasis on automation of the operation of classification yards and other railroad installations has led to frequent use of automatic control systems for track brakes or, as they are more frequently termed, railroad car retarders. Some control systems are based entirely upon the speed of the cars entering and leaving the retarder. A particularly advantageous example of an automatic speed control for a railroad car retarder, in which the speed of a car or cut of cars is continuously monitored from a time preceding entry into the retarder until the time of exit from the retarder, is described and claimed in the co-pending application of Richard E. Porter and Arthur R. Crawford, Ser. No. 427,537 filed Jan. 13, 1965, now Patent No. 3,240,930. Other known control systems are actuated in response to additional factors affecting car movement, such as the weight of the car, wind velocity, and the like. In virtually all of these systems, however, the common denominator is the requirement for release of the car or cut of cars from the retarder at a particular exit velocity.

In a large classification yard, a substantial number of individual retarders may be employed to control movements of individual cuts of cars through the yard. By way of example, the number of retarders in a given classification yard may frequently be in excess of twenty. Each of these retarders requires individual control and, for maximum efficiency, it is usually preferable to afford automatic control for each of the retarders. Thus, the investment in control systems for the car retarders in a major classification yard is quite substantial.

On the other hand, in virtually any yard only a limited number of retarders are actually in operation at any given time. Thus, in a yard containing as many as twenty individual retarders, there may never be more than five retarders actually in operation even during peak operations. In that same yard, normal working conditions may well be such that no more than three or four retarders function simultaneously. It is thus seen that the control equipment for regulating operation of the retarders is quite redundant where, in accordance with normal practice, a complete control system is provided for each retarder.

It is not ordinarily possible to provide a single control system for simultaneously controlling all retarders because the control requirements with respect to individual retarders located at different points within a classification yard may be subject to substantial variation. For example, the safe release speed from one retarder in a given yard may be approximately five miles per hour whereas the permissible release speed for another retarder in the same yard may be only three miles per hour. Furthermore, the desired and permissible exit speeds for individual retarders may vary with changing conditions in the yard. These variations may be even more pronounced with respect to retarders located in a series of small classification yards, as might be the case in the environs of a large metropolitan center.

It is an object of the present invention, therefore, to eliminate excessive duplication of retarder control equipment, and at the same time provide for individual regulation of operation of each car retarder, in a large automated railroad classification yard or any other railroad installation entailing a substantial number of car retarders located in reasonable proximity to each other.

Another object of the invention is to provide for individual automatic control of each of a relatively large number of railroad car retarders in a selective control system affording only a limited number of control units, the number of control units being substantially smaller than the number of controlled car retarders.

A further object of the invention is to provide a new and improved selective automatic control system for railroad car retarders that can be readily adapted to individually set control levels for each controlled retarder, to selective exit speed control in accordance with destination, or to virtually any other basic form of exit speed determination without requiring substantial modification of the control system itself.

A specific object of the invention is to provide for automatic control of a large number of car retarders from a limited number of individual control units that may be adapted to direct speed control or to control in accordance with a wide variety of different environmental factors without basic change of the selection system.

Accordingly, the invention relates to a selective control system for a given number m of railroad car retarders in a freight car classification system. The control system comprises a plurality n of retarder control units each capable of controlling operation of any one of the retarders, n being substantially smaller than m. The system also comprises n selector means, each coupled to an individual one of the retarder control units and each also coupled to all of the railroad car retarders. Each of the selector means includes means for selectively connecting its one control unit to any one of the retarders to control operation of that retarder. The system further includes sequence control means, connected to each of the retarders and to each of the selector means, for actuating the selector means in sequence and in response to the presence of a cut of cars in any one of the retarders, causing the actuated selector means to connect its control unit to the retarder in which a cut is present so that the control unit controls operation of the retarder during movement of the cut through the retarder.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration, show preferred embodiments of the present invention and the principles thereof and what is now considered to be the best mode contemplated for applying these principles. Other embodiments of the invention embodying the same or equivalent principles may be made as desired by those skilled in the art without departing from the present invention and the purview of the appended claims.

In the drawings:

FIG. 1 is a functional block diagram of a selective automatic control system for railroad car retarders constructed in accordance with one embodiment of the present invention;

FIG. 2 is a more detailed block diagram of a part of the system of FIG. 1, showing the selective control system in more complete form;

FIG. 3 is a detail circuit diagram of a selector means that may be incorporated in the control system of FIG. 2; and

FIG. 4 is a detail circuit diagram of a sequence control circuit that may be used in the control systems of FIGS. 1 and 2.

FIG. 1 illustrates a selective automatic control system **10** for controlling the operations of a series of individual railroad car retarders illustarted by retarders **11**, **12**, **13**, **14**, **15** and **16**. In a typical system, the number of retarders actually present might be, and usually would be, substantially larger. Thus, in a major classification yard, it is not uncommon to have twenty or more retarders present.

In the control system **10** of FIG. 1, there are three individual retarder control units **21**, **22** and **23**. Each of the retarder control units **21–23** is capable of controlling the operation of any one of the individual retarders **11–16**. However, the number of retarder control units is substantially smaller than the number of retarders and the control units are not permanently connected to the retarders. Instead, the retarder control units are selectively connected to individual retarders through a selector apparatus **17**.

Selector apparatus **17** includes a plurality of selector means, one for each of the retarder control units **21–23**, together with a sequence control means for actuating the individual selector means, as described more fully hereinafter in connection with FIG. 2. The operating units within selector apparatus **17** are employed to connect the retarder control units to the retarders in accordance with activity occurring at the retarders, and exercise control over the retarders pursuant to commands stored in a control command storage unit **18**.

In a given instance, for example, a cut of cars may be passing through retarder **11**. As the cut enters the retarder, an indication of this activity is transmitted to selector apparatus **17** by means of an electrical connection **24** and the activity is also signalled to the control command store **18** through an electrical connection **24A**. Selector apparatus **17** identifies an idle retarder control unit. In this instance, it is assumed that retarder control unit **21** is idle. The selector apparatus then establishes operating connections between retarder **11** and control unit **21** as indicated by the dash lines **25** and **26** in FIG. 1. The electrical connections **25** and **26** transmit speed information from retarder **11** to control unit **21** and transmit control information for operation of the retarder from unit **21** back to retarder **11**. In addition, a connection is completed from the control command store **18** to retarder control unit **21**, as indicated by the dash line connection **27**, to condition the retarder control unit for the specific release speed requirements of retarder **11**.

A second cut may enter retarder **15**, for example, while the first cut is still passing through retarder **11**. Under these circumstances, activity in retarder **15** is signalled to selector apparatus **17** and to control command store **18** as before. The selector apparatus establishes the necessary operating connections between retarder **15** and the next available control unit, retarder control unit **22**. In addition, an operating connection is made from the control command store **18** to retarder control unit **22** to condition unit **22** for a release speed corresponding to the particular requirements of retarder **15**. These electrical connections are also indicated by appropriate dash lines within selector apparatus **17**, dash lines having been used because the connections are temporary in nature and are maintained only while the cut is moving through the retarder. In subsequent cycles of operation, any one of retarders **11** through **16** may be connected, at a given time, to any one of retarder control units **21**, **22** and **23**.

The selective control system **10** illustrated in FIG. 1 is based upon individual manual or other settings for release speeds for the retarders, the settings being stored in command store **18**. The control command store could be eliminated entirely if the construction of the classification yard containing retarders **11–16** were such that a single fixed speed of release could be employed for all retarders. On the other hand, in some yards the release speeds for the retarders may vary in accordance with destination; that is, a particular retarder such as retarder **11** might require operation for two or more different release speeds depending upon the ultimate destination of a given cut of cars passing through the retarder. A similar variable situation is presented where it is desired to control operation of the retarder on the basis of other factors such as the weight of the car or cars. Where such variations are to be taken into account, through either automatic or pre-set release speed determining apparatus, the release speed determination equipment may be coupled to control command store **18** to determine the control commands supplied to retarder control units **21–23**.

FIG. 2 illustrates a larger selective control system **30** for a classification yard or other railroad installation including a larger number of retarders. In this instance, twelve retarders are incorporated in the system, being represented in FIG. 2 by retarders **31**, **32**, and **33**, and retarders **41** and **42**, with the intervening retarders being omitted from the drawing.

Retarder **31** is electrically connected to a cut detector circuit **51**. Similarly, retarders **32**, **33**, **41** and **42** are individually electrically connected to detector circuits **52**, **53**, **61** and **62** respectively. That is, there is a separate cut detector for each of the retarders. Cut detector **51** is electrically connected to each of a series of five selector devices identified by reference numerals **70A**, **70B**, **70C**, **70D** and **70E**. Each of the remaining cut detectors for the retarders is individually electrically connected to each of the separate selector means **70A** through **70E**. In addition, each of the cut detectors is individually electrically connected to a sequence control unit **67**. The sequence control means **67** is in turn connected to each one of the separate selector means **70A** through **70E**.

Each of the selector means **70A** through **70E** is individually electrically connected to a particular retarder control unit, the retarder control units being identified by reference characters **71A** through **71E**. That is, selector means **70A** is connected to retarder control unit **71A** but is not connected to the other retarder control units of the system. Similarly, selector means **70B** is connected only to retarder control unit **71B**, etc. In addition, output connections are provided from each of the selector means **70A** through **70E** back to all of the retarders in the system as generally represented by retarders **31**, **32**, **33**, **41** and **42**. It will be understood that corresponding connections from the selector means are provided to the remaining retarders that have been omitted from FIG. 2.

In considering the operation of the selective control system illustrated in FIG. 2, it may first be assumed that a car or cut of cars enters the portion of track in the system encompassing retarder **31**. The presence of the cut is detected by device **51**, which signals sequence control means **67** of the presence of a cut in retarder **31**. The sequence control means identifies one of the selector means **70A** through **70E** that is not presently in use and completes an internal connection within the selector means to couple the cut detector **51** to the retarder control unit that is connected to the selector means. For example, sequence control means **67**, in the instance under consideration, may actuate selector means **70A** to connect retarder control **71A** to cut detector **51** and hence to retarder **31**. Only one of the selector means is actuated by sequence control means **67** in response to any one signal from a cut detector; consequently, only retarder control unit **71A** is effectively connected to retarder **31** to control its operation while the cut passes through the retarder. When the cut leaves the retarder, its departure is signalled to selector means **70A** through cut detector **51** and the selector means operates to break the connection between control unit **71A** and retarder **31**, leaving the control unit free for use with another retarder.

The process described above is carried on continuously by control system **30**. Each time a car or cut of cars enters one of the retarders, that retarder is automatically connected to one of the retarder control units by means of the sequence control **67** and the individual selectors **70A** through **70E**. The selected retarder control unit maintains control of the retarder until the car or cut of cars leaves the retarder, at which time the selector automatically disconnects the operating connection and releases the retarder control unit for subsequent operations.

FIG. 3 illustrates operating circuits that may be utilized for the cut detectors **51** and **52**, together with an operating circuit that may be employed for the selector means **70A** in FIG. 2. It should be understood that selector means **70A**, as illustrated in FIG. 3 is generally typical of the selector means **70B** through **70E**, since all of the selectors in a given installation would usually be of the same construction.

Cut detector **51**, as illustrated in FIG. 3, comprises a track relay having an operating coil **1TRR**. One terminal of coil **1TRR** is connected to a suitable power supply, designated as V+, through a normally open test switch **1TSW**. The other terminal of coil **1TRR** is returned to system ground. A switch **1RSW** is shown connected in parallel with test switch **1TSW**. Switch **1RSW** would normally constitute a set of relay contacts or other appropriate track circuit means capable of maintaining the energizing circuit for the track relay **1TRR** as long as a car or cut of cars remains in the section of track encompassing retarder **31**. If automatic route switching is employed in the classification yard, switch **1RSW** may be a part of the detection and control apparatus used for route switching. An appropriate indicator light **81** may be connected in parallel with coil **1TRR** to give a visual indication to the system operator that a car or cut of cars is present in retarder **31**.

Cut detector **51** further includes an auxiliary track relay comprising an operating coil **1TXR**. One terminal of coil **1TXR** is grounded and the other terminal is connected through a resistor **91** and a pair of normally open track relay contacts **1TRR1** to the V+ supply.

The second cut detector **52** shown in detail in FIG. 3 is similar in construction to detector **51**. It comprises the operating coil **2TRR** of a track relay which is arranged for energization through either a test switch **2TSW** or a retarder occupancy sensing switch **2RSW**. As before, an appropriate indicator light **82** may be connected in parallel with coil **2TRR**. In detector **52**, there is an auxiliary track relay operating coil **2TXR** that is energized through the series combination of a resistor **92** and a pair of normally open contacts **2TRR1**.

Selector means **70A**, as illustrated in FIG. 3, comprises a multiple stage rotary stepping switch **1SSA**. In the illustrated arrangement, the rotary switch **1SSA** has five stages, each with a total of twelve operating contacts and a home contact; the wiper arm for each stage is shown in the home position. The rotary switch **1SSA** may be of a type frequently used for telephone and other communication applications and is stepped from one position to another, with all stages moving simultaneously, by means of an electromagnet M1SSA. In a typical switch of this kind, each of the five wiper arms **101**, **102**, **103**, **104** and **105** of the selector switch **1SSA** is advanced, simultaneously with

the other arms, by one step each time the electromagnet M1SSA is energized and subsequently de-energized. That is, stepping of switch **1SSA** occurs upon de-energization of its coil M1SSA.

The first stage of stepping switch **1SSA**, comprising wiper arm **101**, has its initial operating contact, after the home contact, electrically connected to the terminal **111** in cut detector **51** between resistor **91** and coil **1TXR**. Similarly, the second operating contact engageable by wiper arm **101** is connected to the terminal **112** in cut detector **52** between coil **2TXR** and resistor **92**. Corresponding connections are made from the remaining ten terminals of the first stage of stepping switch **1SSA** to the other cut detectors **53–62**, respectively (see FIG. 2). Wiper arm **101** is connected through a pair of normally open homing relay contacts **AHR1** to system ground.

The second and third stages of stepping switch **1SSA**, comprising the wiper arms **102** and **103**, are employed to connect a speed controller **121** to the individual retarders in the system. Thus, the initial contact engageable by wiper arm **102**, upon stepping of the wiper arm from the home position as illustrated, is electrically connected to retarder **31**. The second operating contact of the stage of stepping switch **1SSA** comprising wiper arm **102** is electrically connected to retarder **32**. The third operating terminal of this stage of the stepping switch **1SSA** is electrically connected to retarder **33**. The initial operating terminal of the third stage of stepping switch **1SSA**, comprising wiper arm **103**, is electrically connected to retarder **31**. The second operating terminal is connected to retarder **32** and the third operating terminal is connected to retarder **33**. Similar connections are made from the remaining operating terminals of these two stages of stepping switch **1SSA** to the other retarders controlled by the system. The "home" or "normal" contact in each of the first three stages of switch **1SSA** is left open-circuited.

The wiper arm **102** in the second stage of stepping switch **1SSA** is electrically connected to the speed controller **71A** through a pair of normally open main relay contacts **AMR1**. Similarly, wiper arm **103** in the third stage of the stepping switch is electrically connected to retarder control unit **71A** through a pair of normally open relay contacts **AMR2**. The construction of controller **71A** is not critical with respect to the present invention; it may be of the kind described and claimed in the aforementioned application of Porter and Crawford Ser. No. 427,537, but other forms of speed control apparatus may be utilized. The provision for two electrical connections from each retarder to the control unit makes it possible to transmit actual speed measurements from the retarder to the controller as well as to transmit control signals to the retarder from unit **71A**. In a given installation, more than two electrical connections may be required to effect the requisite control of the retarder; selector means **70A** can be readily modified to provide additional connections as described more fully hereinafter.

The fourth stage of stepping switch **1SSA**, comprising wiper arm **104**, has the "home" contact for the wiper arm returned to system ground through a pair of normally closed relay contacts **APR1**. The initial contact of this stage of the stepping switch, following the "home" contact, is connected by a conductor **131** to the sequence control means **67** described more fully hereinafter in conjunction with FIG. 4. The second and third contacts of this stage of the stepping switch **1SSA** are similarly connected, by conductors **132** and **133** respectively, to sequence control means **67**. Corresponding connections are provided for each of the twelve individual operating contacts of the fourth stage of stepping switch **1SSA**. The wiper arm **104** of this stage of the stepping switch is connected to one terminal of the operating coil **1ASR** of a first selector relay connected in selector means **70A**, the other terminal of coil **1ASR** being connected to the V+ supply for the system.

One terminal of the electromagnet M1SSA for stepping switch 1SSA is connected to system ground. The other terminal of the coil is connected to the V+ supply through the internal stepping switch contacts 1SSA1 and through the series combination of a pair of normally closed main relay contacts AMR3 and a pair of selector relay contacts 1ASR1. Contacts 1SSA1 are of a kind normally provided in communication stepping switches of the type described above, and are opened each time electromagnet M1SSA is energized.

Selector means **70**A further includes a first auxiliary relay having an operating coil AXR located in FIG. 3 immediately to the right of electromagnet M1SSA. One terminal of coil AXR is connected to system ground. The other terminal of the coil is connected to the V+ supply through a pair of normally open homing relay contacts AHR2. This terminal of relay coil AXR is provided with a holding circuit comprising a normally open pair of contacts AXR1 in the same relay and a pair of contacts 1SSA2 controlled by the stepping switch magnet M1SSA. Contacts 1SSA2 are of the kind normally identified as "off normal springs" contacts in a conventional stepping switch and remain open only as long as the stepping switch is in its "home" or "normal" position as illustrated in FIG. 3. For all other positions of the stepping switch, contacts 1SSA2 are closed.

Selector means **70**A further includes a homing relay comprising an operating coil AHR. One terminal of coil AHR is connected to system ground and the other terminal is connected to the V+ supply through an energized circuit, comprising in series, a pair of normally open selector relay contacts 1ASR2 and the stepping switch "off normal" contacts 1SSA2.

The fifth stage of stepping switch 1SSA, comprising wiper arm **105**, is employed to couple stepping switch 1SSA to a second stepping switch 2SSA. The wiper arm **105** in this stage is connected directly to system ground. The "home" or "normal" contact is left open-circuited. The initial operating contact, following the "home" contact in this stage of switch 1SSA, is electrically connected to the first operating contact of the stepping switch 2SSA. The second operating contact engageable by wiper arm **105** is connected to the second operating contact engageable by the wiper arm **135** of stepping switch 2SSA. A similar pattern is maintained for the remaining contacts of the fifth stage of stepping switch 1SSA and the operating contacts of switch 2SSA. The "home" or "normal" contact of stepping switch 2SSA is connected to system ground through a pair of normally closed homing relay contacts AHR3.

The wiper arm **135** of stepping switch 2SSA is connected to a pair of auxiliary relay contacts AYR1 that are returned to system ground. The wiper arm is also electrically connected to one terminal of the operating coil 2ASR of a second selector relay, the other terminal of coil 2ASR being directly connected to the V+ supply.

Stepping switch 2SSA is preferably of the same basic construction as described above for switch 1SSA, and is actuated by an electromagnet M2SSA. One terminal of the stepping switch magnet is connected to system ground and the other terminal is connected to the V+ supply through a pair of normally closed internal contacts 2SSA1 for the stepping switch connected in series with a pair of normally closed selector relay contacts 2ASR1.

Selector means **70**A further includes a failure or cancellation relay comprising an operating coil AFR. One terminal of failure relay coil AFR is connected to system ground and the other terminal is connected through a switch PB to two of the contacts for one pole ASW1 of a three-pole three-position control switch. Two poles ASW1 and ASW2 for this control switch are illustrated in FIG. 3; the third pole of the switch is shown in FIG. 4. The third contact of switch ASW1 is left open-circuited. The three positions for switch ASW1, relating to the three contacts of the switch proceeding from left to right as seen in FIG. 3, are an off position, a test position, and an active position, switch PB being connected to both the "test" and "active" contacts of the switch. A holding circuit for failure relay coil AFR is provided by the normally-open relay contacts AFR1 connected in parallel with switch PB. An indicator light **136** may be connected in parallel with coil AFR to give the system operator a positive indication of energization of the failure relay.

The auxiliary relay coil AYR is illustrated in the lower right-hand corner of FIG. 3. One terminal of this coil is connected to system ground and the other terminal of the coil is connected to an energizing circuit comprising, in series, the normally open selector relay contacts 2ASR2, a diode **137**, a pair of normally open stepping switch contacts 2SSA2, and a pair of normally open homing relay contacts AHR4. Contacts 2SSA2 are "off normal" contacts for the stepping switch 2SSA and are closed for all positions of the stepping switch except its "home" or "normal" position. A holding circuit is provided for coil AYR comprising, in series, two pair of normally open auxiliary relay contacts AYR2 and AXR2.

The main or master operating relay for selector means **70**A comprises a coil AMR illustrated in the lower right-hand corner of FIG. 3 and the contacts AMR1–AMR3 described above. One terminal of coil AMR is connected to system ground. The other terminal of this coil is connected to the right-hand or "active" contact of control switch ASW2. The movable contact of switch ASW2 is connected, through a pair of normally open auxiliary relay contacts AYR3 and through the homing relay contacts AHR4, to the V+ supply. An indicator lamp **141** may be connected in parallel with the main relay coil AMR to afford the operator a positive indication that the main operating relay of the selector is energized, thereby indicating that the selector is in use connecting a retarder control unit to a retarder.

The "test" contact of switch ASW2, the middle one of the three contacts, is connected to an indicator lamp **142** that is returned to ground. The remaining contact of switch ASW2, the "off" contact is open-circuited, as is the "off" contact for switch ASW1.

FIG. 4 illustrates minor portions of the selector means **70**A and a corresponding part of selector **70**B, together with the sequence control means **67** and the external connections to the sequence control means. Sequence control means **67** comprises a multiple-stage stepping switch SS1. Two stages of switch SS1, comprising wiper arms **145** and **146**, are shown in FIG. 4. Stepping switch SS1 may be of the same general kind as stepping switches 1SSA and 2SSA (FIG. 3) except that its stages need not include a "home" position contact, employing only the twelve operating contacts necessary to afford one contact for each retarder in each stage of the stepping switch. Although only two stages of stepping switch SS1, connected to selector means **70**A, are shown in FIG. 4, there are eight additional stages including in this switch, providing two corresponding stages in the stepping switch for each of the individual selector units **70**B through **70**E.

The initial operating terminal in the first stage of stepping switch SS1, comprising wiper arm **145**, is connected to a pair of normally closed auxiliary track relay contacts 1TXR1. Contacts 1TXR1 are returned to system ground. Similarly, the second contact of this stage of stepping switch SS1 is connected through a pair of normally closed auxiliary track relay contacts 2TXR1 to system ground. Each of the remaining contacts in this stage of the stepping switch is similarly returned to system ground through a normally closed pair of auxiliary track relay contacts.

The first operating contact engageable by the wiper arm **146** in the second stage of stepping switch SS1 is electrically connected to the conductor **131** leading to the first operating contact in the fourth stage of the stepping switch 1SSA in selector means **70**A, FIG. 3.

This same contact is connected through a pair of normally open track relay contacts **1TRR2** to a diode **151**. Diode **151**, in turn, is connected through the series combination of a pair of normally open homing relay contacts AHR5 and a pair of normally open failure relay contacts AFR2 to system ground.

Similarly, the second contact engageable by wiper arm **146** is connected to the conductor **132** leading to the selector means **70**A in FIG. 3. This contact of switch SS1 is also connected through a pair of normally open track relay contacts 2TRR2 (a part of cut detector **52**) and a diode **152** to the conductor **159** connected to homing relay contacts AHR5. Corresponding connections are provided for the succeeding contacts of this stage of switch SS1. Moreover, a similar circuit arrangement is utilized for each of the stepping switch stages (not shown) included in sequence control means **67** and connected to selector means **70**B–**70**E.

The wiper arm **146** in the second stage of stepping switch SS1 is electrically connected to a pair of normally closed auxiliary relay contacts AXR3 which are in turn connected to a pair of normally open failure relay contacts AFR3, the latter being returned to ground.

One of the principal operating relays of sequence control relays **67**, FIG. 4, is a track sequence relay comprising an operating coil TSR. One terminal of coil TSR is connected to system ground and the other terminal **161** is connected to the V+ supply through a resistor **162**. Terminal **161** is also connected to the wiper arm **145** of stepping switch SS1 and to the wiper arms of the other stages of stepping switch SS1 (not shown) incorporated in sequence control means **67** for connection to selectors **70**B through **70**E.

The electromagnet MSS1 for actuating the multiple stage stepping switch SS1 is shown in FIG. 4 immediately to the right of relay coil TSR. One terminal of electromagnet MSS1 is connected directly to the V+ supply. The other terminal is connected to a pair of normally closed internal stepping switch contacts SS11 which are in turn connected through a pair of normally closed track sequence relay contacts TSR1 to conductor **163**. Contacts SS11 open each time the electromagnet MSS1 is energized. Conductor **163** is provided with a plurality of return circuits to system ground, each including a pair of normally open contacts in one of the retarder cut detector circuits. That is, conductor **163** is connected to a pair of normally open auxiliary relay contacts 1TXR2 from the first cut detector, these contacts being returned to ground. The same arrangement is employed for auxiliary track relay contacts 2TXR2 and 3TXR2, one such pair of contacts from each cut detector.

Sequence control means **67** further includes a four-stage rotary stepping switch SS2, the individual stages of which are illustrated at the right-hand side of FIG. 4. The electromagnet MSS2 for switch SS2, which may be similar in construction to stepping switch SS1, is located in the central portion of the drawing. One terminal of electromagnet MSS2 is connected to system ground. The other terminal of the electromagnet is connected through a pair of normally closed stepping break relay contacts SBR1 to a conductor **164**.

Three different circuits are provided for connecting conductor **164** to the V+ supply. The first of these circuits comprises a pair of normally open contacts TSR2 of the track sequence relay, which are connected directly between conductor **164** and the V+ supply. The second circuit is provided by a normally open pole SPB1 of a manually operated sequence switch. The third circuit is afforded by a normally closed pole SPB2 of the same switch which connects conductor **164** to the wiper arm **171** in the first stage of stepping switch SS2. The first five contacts engageable by wiper arm **171** do not afford a connection to the V+ supply, but are left open-circuited. However, the last five contacts engageable by wiper arm **171** do afford a connection to the V+ supply. It should be noted that switches SPB1 and SPB2 act conjointly, pole SPB1 opening each time pole SPB2 is closed.

The wiper arm **171** in the first stage of stepping switch SS2 is also connected directly to the wiper arm **172** in the second stage of this switch. The initial operating contact engaged by wiper arm **172** (there are no "home" contacts in stepping switch SS2) is electrically connected to the two right-hand contacts of the third pole ASW3 of the main control switch, these being the "active" and "test" contacts for this switch. The left-hand contact for switch ASW3 is again the "off" contact. The movable contact of switch ASW3, which is actually a part of selector **70**A, is electrically connected through the series combination of two pair of normally closed stepping switch contacts 1SSA3 and 2SSA3 to a pair of normally open position relay contacts APR4, the contacts APR4 being returned to the conductor **164**. Contacts 1SSA3 are "off normal" contacts for the stepping switch 1SSA (FIG. 3) and are open whenever that stepping switch is not in its "home" or "normal" position. Contacts 2SSA3 are a similar pair of "off normal" contacts for the stepping switch 2SSA (FIG. 3) and are open for all positions of that stepping switch except the "home" position.

The operating coil APR for the position relay of selector means **70**A is also shown in FIG. 4 near the lower right-hand corner of the figure. One terminal of coil APR is connected to system ground and the other terminal is connected to the conductor **164** through the series combination of a pair of normally open failure relay contacts AFR4 and the position relay contacts APR4, contacts APR4 affording a holding circuit for the APR relay. Initial energization of coil APR is achieved through the circuit comprising contacts 2SSA3 and 1SSA3 and switches ASW3 and SS2, as described more fully hereinafter.

The connection afforded for the contact engaged by wiper arm **172** in the second stage of stepping switch SS2 is the same as described above for the first contact except that the second contact is connected to circuit components in the second selector means **70**B. Thus, the second operating contact engageable by wiper arm **172** is connected through a switch BSW3 and two pair of normally closed "off normal" stepping switch contacts 1SSB3 and 2SSB3 to a pair of normally open position relay contacts BPR4 that are returned to the conductor **164**. The same circuit extends from the terminal of contacts 2SSB3 and BPR4 and through a pair of normally open failure relay contacts BFR4 to the position relay coil BPR in the second selector means **70**B and thence to ground. Corresponding connections (not shown) are provided to selectors **70**C, **70**D and **70**E from the third, fourth and fifth contacts in the second stage of switch SS2. The remaining five contacts engageable by wiper arm **172** remain open-circuited.

The wiper arms **171** and **172** in stepping switch SS2 are connected to the third stage wiper arm **173** of the stepping switch through a circuit comprising, in series, a pair of normally open internal stepping switch contacts SS22 and a stepping break relay coil SBR. Contacts SS22 are actuated each time the stepping switch electromagnet MSS2 is energized.

The first operating terminal in the third stage of switch SS2, comprising wiper arm **173**, is returned to ground through a pair of normally closed position relay contacts APR3 of selector means **70**A. The second terminal in this stage of the stepping switch is similarly returned to ground through a pair of normally closed position relay contacts BPR3 in the second selector means **70**B. Corresponding connections, through selector means **70**C, **70**D and **70**E (not shown), are provided for the third, fourth and fifth contacts in the third stage of switch SS2. The remaining five contacts in this stage of the switch are directly connected to system ground.

The wiper arm **174** in the fourth stage of stepping switch SS2 is connected to system ground. The first operating contact engaged by the wiper arm is connected to an indicator lamp **175**A which is in turn connected to internal stepping switch contacts 1SSA4 that are controlled by the stepping switch 1SSA of selector means 70A (FIG. 3). As shown in FIG. 4, contacts 1SSA4 are connected to the V+ supply to provide energization of lamp 175A. A similar circuit including an indicator lamp 175B and internal stepping switch contacts 1SSB4 is connected between the second contact of this stage of switch SS2 and the V+ supply. Corresponding indicator lamp circuits (not shown) are provided for the third, fourth and fifth contacts of this stage of stepping switch SS2, the connections being incorporated in selector means 70C, 70D and 70E respectively.

In considering operation of the cut detector, selector means, and sequence control circuits illustrated in FIGS. 3 and 4, it may first be assumed that track relay coil 1TRR (FIG. 3 upper left-hand corner) in cut detector 51 is energized. This is effected by closing of switch 1RSW, for an actual detection of cut presence, or may be simulated for test purposes by closing of switch 1TSW. Upon energization of the track relay coil, contacts 1TRR1 close, completing an operating circuit for the auxiliary track relay coil 1TXR through resistor 91.

It may happen that the position of switch SS1 (FIG. 4) is already such that wiper arm 145 is aligned with the initial contact in this stage of the stepping switch, connecting the wiper arm to auxiliary track relay contacts 1TXR1. Under these circumstances, the opening of contacts 1TXR1 is effective to energize the track sequence relay coil TSR, since the opening of these contacts removes the shunt to ground that was previously present with respect to coil TSR. Moreover, although the auxiliary track relay contacts 1TXR2 are closed, energization of the track sequence relay coil TSR and the consequent opening of its contacts TSR1 prevents completion of an energizing circuit for the stepping switch electromagnet MSS1, even though contacts SS11 are already closed. The track sequence relay TSR is a fast-operating relay and is effective to open contacts TSR1 before coil MSS1 can be energized, by closing of contacts 1TXR2, for a time sufficient to step switch SS1. Under these circumstances, the stepping switch SS1 does not move, having already and previously been aligned at the position for connecting the active retarder, retarder 31, to the retarder control unit 71A through selector means 70A as described more fully hereinafter.

More typically, selector switch SS1 may be at some other position than that illustrated in FIG. 4. For example, if it is assumed that wiper arm 145 initially engages one of the other contacts clockwise from the position shown, it will be seen that coil TSR is not affected by the opening of contacts 1TXR1 in the cut detector for the first retarder and hence remains unenergized. Under these circumstances, the closing of contacts 1TXR2 signifying the entrance of a cut of cars into retarder 31 completes an operating circuit to the stepping switch electromagnet MSS1. The stepping switch magnet is energized and upon energization, opens its own contacts SS11. Opening of these contacts de-energizes the stepping switch solenoid and advances the stepping switch one position. This operation continues through as many steps as are necessary to bring wiper arm 145 into engagement with the first contact, connected to the auxiliary track relay contacts 1TXR1, which are now open. When that position is reached, sequence relay coil TSR is energized and further advancement of the stepping switch is prevented as described above.

It is quite possible for more than one retarder to be active at the same time. When this occurs, switch SS1 advances as described above until it reaches the first contact connected to a pair of auxiliary track relay contacts that have been opened by the cut detector circuit associated with one of the active retarders. Thereafter, there is no further stepping of switch SS1 until the first active retarder has been connected to a speed controller, at which time switch SS1 moves on to find the next active retarder.

Having identified an active retarder by the stepping of switch SS1, as described above, the next function of the sequence control circuit 67 of FIG. 4 is to locate an idle retarder control unit, one of units 71A–71E. The search for an idle control unit is conducted by stepping switch SS2, the position of which identifies the control unit next scheduled for operation. In FIG. 4, the position of stepping switch SS2 indicates that retarder control unit 71A is the next to be utilized and is to be connected to the active retarder through selector means 70A.

As indicated above, the identification of activity in retarder 31 requiring control has resulted in energization of the track sequence relay TSR. As a consequence, contacts TSR2, located in the upper right-hand portion of FIG. 4, are closed. This completes an operating circuit for the position relay APR of selector means 70A, the circuit extending from the V+ supply through contacts TSR2 and through the normally closed switch SPB2 to wiper arm 172 of switch SS2, which, as noted above, is presently engaged with the first contact as shown in the drawings. From wiper 172, the circuit extends through the "active" contact of switch ASW3 (the switch is assumed to be in its active position) and through the normally closed contacts 1SSA3 and 2SSA3 to the failure relay contacts AFR4. The failure relay is continuously energized during normal operation (its failure function is described hereinafter) so that a complete operating circuit is established for the position relay coil APR. The energization of coil APR and consequent actuation of the APR position relay indicates that selector means 70A and its associated retarder control unit 71A are idle and available.

Next in time sequence, stepping switch electromagnet MSS2, located in the center portion of FIG. 4, is energized. The operating circuit is established through the normally closed contacts SBR1 and through the closing of the track sequence relay contacts TSR2 as noted above. To asure energization of stepping switch magnet MSS2, it is necessary that contacts SBR1 remain closed. To this end, the position relay APR is made a fast-acting relay, relative to the SBR stepping brake relay so that contacts APR3 of the position relay open before coil SBR can be energized long enough to actuate its relay and before the contacts SS22 in series with the SBR coil are closed by energization of electromagnet MSS2. The position relay APR completes its own holding circuit by closing of its contact APR4 in series with the coil APR. But electromagnet MSS2 is not de-energized at this time and switch SS2 is not stepped. This completes the operations for recognition of the availability of speed controller 71A through its selector means 70A.

The situation is substantially different if the selector means 70A is already in operation and has been actuated to connect its speed controller 71A to some other retarder that is already active. This situation is indicated by the fact that either one of both of stepping switches 1SSA and 2SSA (FIG. 3) are displaced from the home or normal position. Under these circumstances, referring again to FIG 4, it is seen that the position relay coil APR cannot be energized because either one or both of the "off normal" contact pairs 1SSA3 and 2SSA3 in the energizing circuit would be open. Since the position relay APR has not been energized, the closing of the track sequence relay contacts TSR2 and consequent energization of stepping switch magnet MSS2, as described above, completes an operating circuit to the stepping brake relay coil SBR upon closing of the contacts SS22 (actuated by the stepping switch solenoid) because contacts APR3 in series with the coil SBR remain closed. Energization of coil SBR causes the normally closed contacts SBR1 in series with stepping switch electromagnet MSS2 to open. The consequent de-energization of electromagnet MSS2 causes stepping switch SS2 to advance one step in search of an idle retarder control unit. As soon as stepping switch SS2 reaches a position connected to a selector means 70B–70E in which the position relay coil such as coil

BPR can be energized, the stepping of switch SS2 stops as described above.

It can be seen that if the control switch ASW has been turned to its "off" position, engaging the left-hand contact of the switch, then the energizing circuit for position relay coil APR is open at switch ASW3 (FIG. 4) and stepping switch SS2 will operate in the same manner as described above for a situation in which the first retarder control unit **71A** is already in use. For convenience, the sequence control means **67** is also provided with a manual indexing circuit for stepping of switch SS2. This is accomplished by actuation of switch SPB1–SPB2, which energizes the stepping switch magnet MSS2 directly and independently of the track sequence relay contacts TSR2. It will be noted that the opening of pole SPB2 in this switch prevents undesired actuation of the selector means position relays such as the APR and BPR relays and also prevents energization of the stepping break relay comprising coil SBR.

In the illustrated arrangement, the last five positions on stepping switch SS2 are not utilized and the switch is advanced directly from the fifth position to the first position by the power supply connection for the last five contacts engageable by wiper arm **171**.

Assuming that speed controller **71A** and its associated selector means **70A** have been recognized as being idle, as indicated by energization of position relay coil APR (FIG. 4), stepping switch 1SSA of selector means **70A** (FIG. 3) starts to advance. The stepping movement of switch 1SSA is initiated upon opening of the position relay contacts APR1 connected to the home position contact in the fourth stage of the switch comprising wiper arm **104**. Opening of these contacts de-energizes the selector relay coil 1ASR and permits the closing of its contacts 1ASR1. The closing of contacts 1ASR1 completes an operating circuit to the stepping switch magnet M1SSA. Upon energization of the electromagnet M1SSA, its contacts 1SSA1 open, causing the switch to advance one step. This process is repeated for as many steps as are necessary until such time as the master relay contacts AMR3 are opened as described hereinafter.

The fourth stage of stepping switch 1SSA, comprising wiper **104**, searches for a ground connection through the interconnection of its individual contacts with the second level of the stepping switch SS1 in the sequence control means **67**, these interconnections being afforded by the conductors **131–133**. As noted above, the position of switch SS1 represents the location of an active retarder; by stopping switch 1SSA at the same position as already occupied by switch SS1, the first step in connecting the retarder control unit to the active retarder is accomplished. In the present instance, where switch SS1 is at its initial position representative of activity in retarder **31**, alignment of the two switches is achieved as soon as switch 1SSA advances one step to bring wiper **104** into engagement with the contact connected to line **131** (FIG. 3), since this completes a circuit to ground from conductor **131** through wiper **146** (FIG. 4) and contacts AXR3 and AFR3. It should be remember that contacts AFR3 are normally closed except in event of a power failure as described more fully hereinafter.

As soon as switch 1SSA advances into alignment with switch 1SS1, as described above, completing an effective connection from wiper **104** to ground (see FIG. 3) selector relay coil 1ASR is again energized. Upon energization of coil 1ASR, its contacts 1ASR1 are opened, preventing further stepping of switch 1SSA because it is no longer possible to energize the electromagnet M1SSA for the stepping switch.

Energization of the selector relay coil 1ASR also closed contacts 1ASR2, in the upper right-hand corner of FIG. 3. Closing of these contacts completes an operating circuit for the homing relay coil AHR, since switch 1SSA has moved away from its normal position and contacts 1SSA2 are closed for all positions of the stepping switch other than the "normal" position. Energization of coil AHR closes contacts AHR2 and energizes the auxiliary relay coil AXR. Actuation of the auxiliary relay closes its contacts AXR1 to establish a holding circuit that is independent of the homing relay.

Energization of the auxiliary relay coil AXR also causes the opening of contacts AXR3 in the sequence control means **67** (FIG. 4). However, opening of these contacts occurs after actuation of the AHR homing relay and hence after closing of contacts AHR5. Recalling that track relay 1TRR2 is previously energized, retarder **31** being active, and that contacts AFR2 are closed because the failure relay is normally held energized, it is seen that the actuation of the homing relay coil AHR and the consequent closing of contacts AHR5 prior to actuation of the auxiliary relay coil AXR and the resultant opening of contacts AXR3 maintains the necessary ground connection for the sequence relay 1ASR through conductor **131**.

Energization of the homing relay coil AHR (FIG. 3) also closes the homing relay contacts AHR1 that are connected to the wiper arm **101** in the first stage of the stepping switch 1SSA. Recalling that the actuation of the homing relay occurs upon stepping of switch 1SSA to its first operating contact away from the "home" position, it is seen that the closing of the contacts AHR1 effectively shunt the operating coil 1TXR of the auxiliary track relay in the first cut detector **51** to ground. As a consequence, the 1TXR auxiliary track relay drops out and its contacts 1TXR1 (FIG. 4 upper left-hand corner) close. The closing of these contacts completes a shunt circuit to ground that is effective to de-energize the track sequence relay coil TSR. The consequent dropping out of the track sequence relay closes contacts TSR1 in the operating circuit for the electromagnet MSS1 that actuates stepping switch SS1. This permits stepping switch SS1 to resume the search for an active retarder, if in fact there is an active retarder as would be indicated by closing of one of the other sets of auxiliary track relay contacts 2TXR2, 3TXR2, etc.

Of course, the other set of track sequence relay contacts TSR2 now open, effectively disconnecting conductor **164** from the V+ supply and de-energizing the stepping switch magnet MSS2. This permits stepping switch SS2 to advance one step and thus prepares the stepping switch for connection to the next speed control unit when such connection is required by occurrence of activity in another retarder.

The operating cycle for selection and maintenance of operating connections between retarder control unit **71A** and a retarder **31** is completed when track relay 1TRR is de-energized by opening of the switch 1RSW or 1TSW that initially energized the track relay to indicate activity in retarder **31**. When this occurs, it is necessary to bring switch 1SSA back to its home position to condition selector means **70A** for subsequent operations. This action is initiated by the opening of contacts 1TRR2 (FIG. 4 lower left-hand corner), which breaks the existing ground connection to conductor **131** and thus de-energizes selector relay 1ASR (FIG. 3). When the selector relay comprising coil 1ASR drops out, its contacts 1ASR1 again close. This permits energization of stepping switch magnet M1SSA which, when energized, opens its own contacts 1SSA1. The opening of contacts 1SSA1 effectively de-energizes the stepping switch magnet and causes the stepping switch to advance one step.

This self-interrupted stepping is maintained until switch 1SSA reaches the home position in which it is illustrated in FIG. 3. At that position, with the position relay coil APR de-energized in the manner described above, and with position relay contacts APR1 consequently closed, selector relay 1ASR is again energized because a ground connection is available through wiper arm **104**. Consequently, contacts 1ASR1 open and the stepping action of switch 1SSA is interrupted because electromagnet M1SSA cannot again be energized. The stepping switch 1SSA remains in the home position until again required to locate an active retarder as described above.

When the stepping switch 1SSA returns to its home position, contacts 1SSA2 open. This is effective to de-energize the homing relay coil AHR and the auxiliary relay coil AXR.

The basic role of the failure relay comprising coil AFR (FIG. 3 lower right-hand corner) is to prevent stepping switch SS2 (FIG. 4) from hanging up in a position associated with a malfunctioning selector means **70A–70E**. For example, a failure in the power supply for one of the individual selector means, and specifically the selector means **70A**, is effective to de-energize the failure relay coil AFR. With the failure relay de-energized, stepping switch SS2 cannot stop on its first position, in which it connects to selector means **70A**, because the consequent opening of contacts **AFR4** prevents energization of the position relay coil APR. It will be recalled that switch SS2 can only remain in position with a selector means where it is possible to energize the position relay coil of the selector means.

When the system is first placed in operation, the failure relay coil AFR (FIG. 3) is initially energized by closing of switch PB and remains energized thereafter by means of a holding circuit established through its own contacts **AFR1**. Whenever a power supply failure occurs, with consequent drop out of the AFR relay, the circuit is reset for operation by momentarily closing switch PB. This action is also necessary if the system has been taken out of operation, as by actuation of the ASW switch to its "off" position, for any reason. Automatic reset upon restoration of power can be provided if desired.

The second stepping switch 2SSA that is incorporated in selector means **70A** is provided primarily to afford additional stages for multiple circuit connections between retarder control unit **71A** and the selector means, although further stages of switch 2SSA have not been illustrated in the drawings. Consequently, switch 2SSA is arranged to step to the same point as switch 1SSA in the course of connecting the selector means and its associated retarder control unit to an active retarder. The main or master relay comprising coil AMR is placed under control of stepping switch 2SSA to complete the operating connections between the active retarder and the retarder control unit.

As noted above, the homing relay coil AHR is energized at the time stepping switch 1SSA stops its stepping at the active retarder (retarder **31** in the example given above). Upon energization of the relay coil AHR, contacts **AHR3** in the lower central portion of FIG. 3 open, interrupting the operating circuit for the second selector relay coil 2ASR. De-energization of this selector relay is effective to cause self-interrupted stepping of switch 2SSA until wiper arm **135** again reaches a contact at ground potential to energize coil 2ASR. That is, stepping switch 2SSA advances by the opening and closing of its own contacts **2SSA1** occasioned by energization of coil M2SSA, since contacts **2ASR1** are now closed. The stepping action is interrupted when wiper arm **135** reaches a point corresponding to the point of advancement of wiper arm **105** in switch 1SSA, since wiper arm **105** is connected to ground and completion of the ground connection again effects energization of coil 2ASR and opens contacts **2ASR1** to break the operating circuit to the stepping switch solenoid.

At the time that selector relay 2ASR is again energized, its contacts **2ASR2** in series with auxiliary relay coil AYR close. When this occurs, the contacts **2SSA2** in series with contacts **2ASR2** are already closed; it will be recalled that contacts **2SSA2** are closed for every position of stepping switch 2SSA other than its "home" or "normal" position. Moreover, contacts **AHR4** are closed because the homing relay has been energized as discussed above. Consequently, the auxiliary relay coil AYR is energized. It establishes a holding circuit by the closing of its contacts **AYR2**, the series contacts **AXR2** already being closed because auxiliary relay AXR has been energized as described before.

Energization of the auxiliary relay coil AYR also closes the contacts **AYR3** of this relay. Inasmuch as contacts **AHR4** are already closed, this completes an energizing circuit for the main or master relay coil AMR, assuming that the ASW switch is in its active position as shown in FIG. 3. Energization of the main relay coil closes contacts **AMR1** and **AMR2** and thus completes two operating circuits between retarder control unit **71A** and the active retarder, in this instance retarder **31**. Of course, it will be understood that the AMR relay may contain additional contacts connecting additional stages in stepping switch 2SSA to the retarder control unit and to the retarder if additional control functions are required.

The main relay AMR should be dropped out before homing of the stepping switches 1SSA and 2SSA upon completion of a control cycle, triggered by the exit of the cut of cars from the previously active retarder as described generally above. This is accomplished by incorporating contacts **AMR3** in series in the operating circuit of stepping switch magnet M1SSA (FIG. 3). As long as the master relay is energized, contacts **AMR3** are open and the stepping switch 1SSA cannot resume stepping action to bring it to "home" position. Stepping of swtch 2SSA is dependent upon operation of switch 1SSA and hence cannot occur prematurely.

It is also desirable to effect the return of switch 1SSA to its home position before switch 2SSA commences homing. This is effected by maintaining selector relay coil 2ASR energized as long as the auxiliary relay coil AYR is energized through the utilization of contacts **AYR1** in the ground circuit for coil 2ASR. Auxiliary relay coil AYR can only drop out when the counterpart relay coil AXR in the control circuit for stepping switch 1SSA is de-energized, dropout of the AYR relay coil being effected by opening of contacts **AXR2**. As described above, the auxiliary relay AXR is de-energized upon switch 1SSA reaching home position to open contacts **1SSA2**. It is clear, therefore, that the AYR relay will drop out only after switch 1SSA has reached home position, at which time the interruption of the operating circuit for coil 2ASR through opening of the relay contacts **AYR1** permits contacts **2ASR1** to close and complete an energizing circuit to stepping switch electromagnet 2SSA. The stepping action of switch 2SSA is interrupted when it reaches its home position and again finds a ground connection through contacts **AHR3**, which have previously closed upon de-energization of coil AHR by homing of switch 1SSA.

The principal purpose in staggering the stepping of switches 1SSA and 2SSA is to reduce power supply requirements. Where speed of connection of an active retarder to a control unit is critical, simultaneous stepping of switches 1SSA and 2SSA can be provided.

In the embodiments described above, stepping switches are employed for identification of active retarders by the sequence control means (switch SS1, FIG. 4), for sequential identification of an available selector means and idle control unit (switch SS2) and for selection of the active retarder by the selector means (switches 1SSA, 2SSA, FIG. 3). It will be recognized, however, that conventional shift registers constructed with vacuum tubes or solid state devices such as transistors, and other forms of electrically or electronically operated stepping devices, such as the crossbar switches employed in communication networks, could be employed for these same purposes. In the appended claims, therefore, all references to "stepping switches" are intended to include such stepping devices in general, without limitation to mechanical switching members. Of course, electronically actuated gate circuits can also be utilized for the relay circuits specifically described above.

As noted above, the stepping switch SS2 is used to identify the next available selector means and control unit combination. The circuit can be arranged to identify that combination in advance instead of waiting until a control unit is actually required, with some saving in search time, if this appears desirable. Of course, auxiliary circuits may be provided to indicate when all control units are in use, and also to indicate when an additional control unit is needed under these circumstances.

From the foregoing description, it is clear that the selective control system of the present invention makes it possible to control a relatively large number of retarders from a substantially smaller number of retarder control units. The number of direct electrical connections between the retarders and the control units is dependent only upon the number of stages that are provided in stepping switches 1SSA and 2SSA, so that the system can be utilized with virtually any form of basic retarder control without substantial modification. Thus, the selective control system is seen to provide a maximum in versatility and at the same time to afford optimum economy in overall system cost.

Hence, while preferred embodiments of the invention have been described and illustrated, it is to be understood that they are capable of variation and modification, and we therefore do not wish to be limited to the precise details set forth, but desire to avail ourselves of such changes and alterations as fall within the purview of the following claims.

We claim:

1. A selective control system for a number of railroad car retarders in a freight car classification system comprising:

- a plurality of independent retarder control units substantially smaller in number than the number of railroad car retarders, each capable of controlling operation of any one of said retarders;
- selector apparatus, coupled to said retarder control units and to said car retarders, for individually selectively completing an operating connection between any one of said control units and any one of said car retarders,
- said selector apparatus including sequence control means for completing said operating connections in accordance with activity at said retarders and availability of said control units;
- a control command store for recording at least one control command signal for each of said retarders;
- and means, included in said selector apparatus, for selectively connecting said control command store to said control units to apply said control command signals to said control units in correspondence with the operating connection of said control units to said retarders.

2. A selective control system for a given number m of railroad car retarders in a freight car classification system comprising:

- a plurality of n independent retarder control units each capable of controlling operation of any one of said retarders, n being less than m;
- a corresponding plurality n of selector means, each coupled to an individual one of said retarder control units and to all of said railroad car retarders,
- said selector means each including means for selectively connecting its one control unit to any one of said retarders to control operation of the retarder;
- and sequence control means, connected to each of said retarders and to each of said selector means, for actuating each of said selector means, in sequence, in response to the presence of a cut in any one of said retarders, to connect said retarder to the control unit associated with said selector means to control operation of that retarder during passage of said cut through said retarder.

3. A selective railroad retarder control system according to claim **2**, comprising m cut detector circuits, one for each retarder and each connected to all of said selector means and to said sequence control means, each of said detector circuits being actuatable from an initial inactive condition to an active condition upon entry of a cut into its associated retarder and further being actuatable back to inactive condition when the cut leaves the retarder, said selector means each including means for interrupting the connection from its control unit to any given retarder whenever the cut detector circuit for that retarder reverts to its inactive condition.

4. A selective railroad retarder control system according to claim **2** in which each of said selector means provides a plurality of electrical connections between its associated control unit and a retarder controlled by the control unit.

5. A selective railroad retarder control system according to claim **4** in which each of said electrical connections is effected through an individual stage of a multiple-stage stepping switch, each stage of said stepping switch having a separate contact for each retarder in the system.

6. A selective railroad retarder control system according to claim **2** in which said sequence control means includes a multiple-stage sequence stepping switch having one contact in each stage connected to each selector means, and advancing means for advancing said sequence stepping switch one contact each time one of said selector means is actuated to connect its control unit to an active retarder.

7. A selective railroad retarder control system according to claim **6** in which one stage of said sequence stepping switch is connected back to said advancing means to actuate said advancing means and advance said sequence stepping switch an additional contact each time said switch is advanced to a contact connected to a selector means already connecting its control unit to an active retarder.

8. A selective railroad retarder control system according to claim **3** in which said sequence control means includes a retarder identification stepping switch having one contact connected to each cut detector, and advancing means for advancing said identification stepping switch one contact at a time, said advancing means being connected to all of said cut detectors for actuation whenever any of said cut detectors is actuated to its active condition and remaining in operation to continue advancement of said identification stepping switch until said switch reaches the contact thereof connected to the cut detector that has been actuated to active condition.

9. A selective railroad retarder control system according to claim **8**, in which said retarder identification stepping switch includes at least a plurality of stages and in which each of said selector means includes a multiple stage retarder selection stepping switch, each stage of said retarder selection switches including one contact for each retarder in the system, and advancing means for advancing said retarder selection stepping switch one contact at a time, the contacts of one stage of each of said retarder selection stepping switches being individually interconnected with the contacts of one stage of said retarder identification switch and being connectible to said advancing means to advance said retarder selection switch to a position corresponding to the position of said retarder identification switch whenever said selector means is actuated.

References Cited

UNITED STATES PATENTS

3,226,541	12/1965	Brinker et al.	246—182
3,251,991	5/1966	Coley et al.	246—182
3,253,142	5/1966	Brown	246—182

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