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Grundy et al.

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[54] STATION STOP CONTROL ARRANGEMENT FOR SELF-PROPELLED VEHICLES

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[52] **U.S. Cl.** .....**246/182 B,** 246/184

[51] **Int. Cl.** **B61l 3/06**

[58] **Field of Search** .....340/164 R, 263; 246/182 B, 184; 307/232; 328/109, 110

[56] **References Cited**

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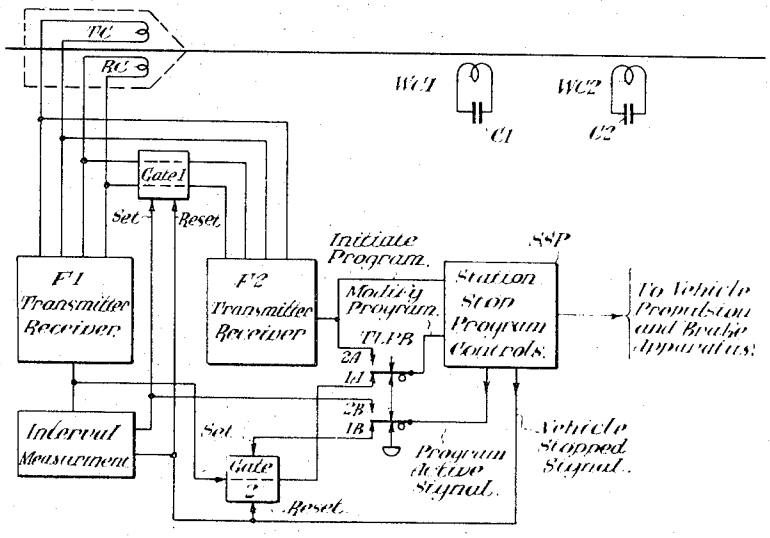
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[57] **ABSTRACT**

Coils tuned to a first and a second frequency are positioned in pairs along the track in approach to the station at which trains are to stop automatically, two pairs being shown. 0the first pair are spaced a distance which establishes a selected passage time in accordance with average train speeds while the second pair are separated a distance proportional to predetermined differences in train lengths. On the train two transmitter and/or receivers are coupled by a common pair of coils to inductively respond to the corresponding frequency wayside coil. Response to the initial first frequency coil opens a gate which enables the other transmitter-receiver for a predetermined time or distance interval to respond to the second frequency wayside coil of the initial pair. Only if the train coils pass this second frequency coil during this gating interval is the station stop program initiated by the response of the second transmitter-receiver. While passing the second set of wayside coils, the response of the first or second transmitter-receiver is selectively used, in accordance with a preset train length condition, to modify the station stop program to improve the accuracy of the station stop position.

9 Claims, 3 Drawing Figures



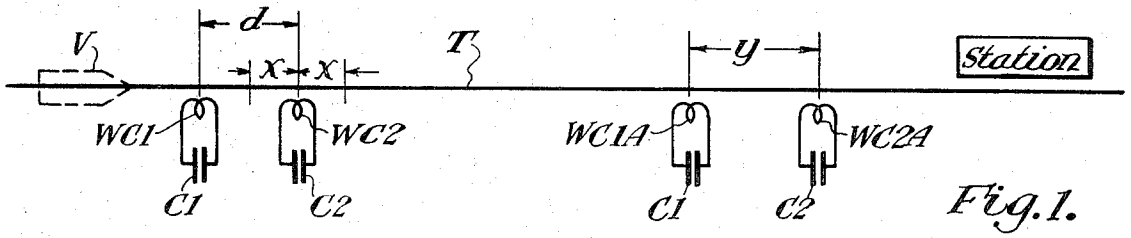


Fig. 1.

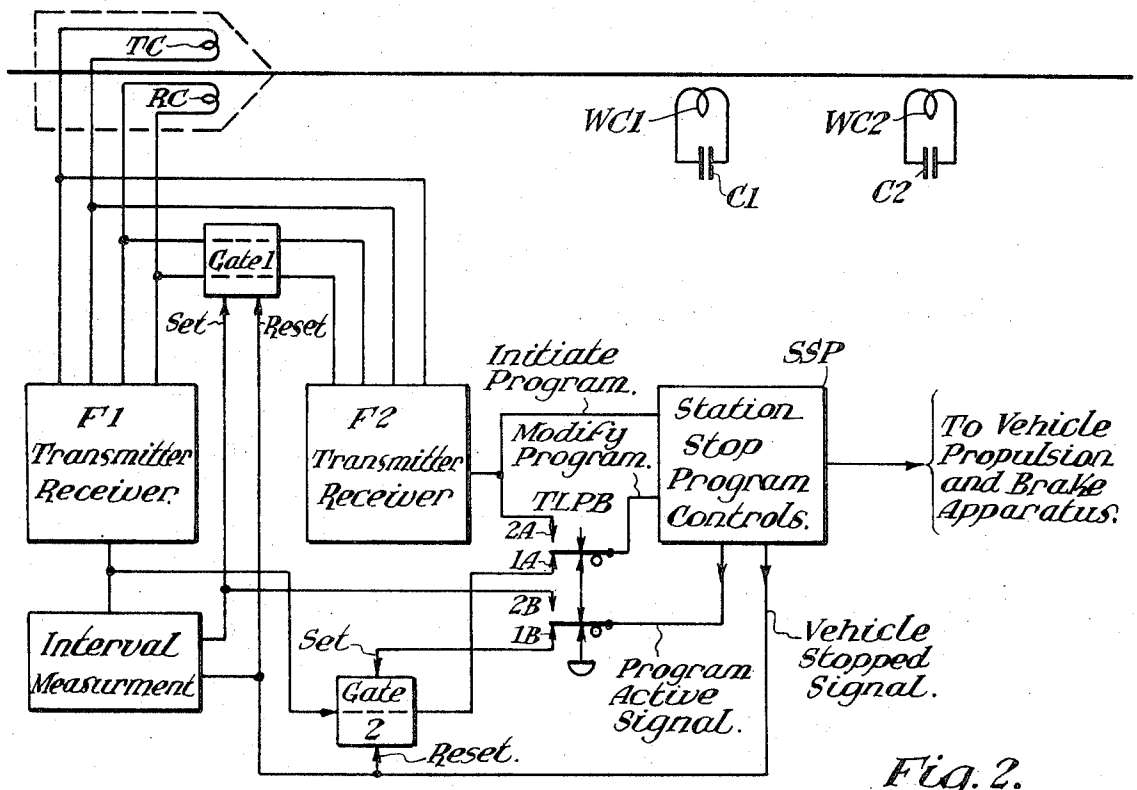


Fig. 2.

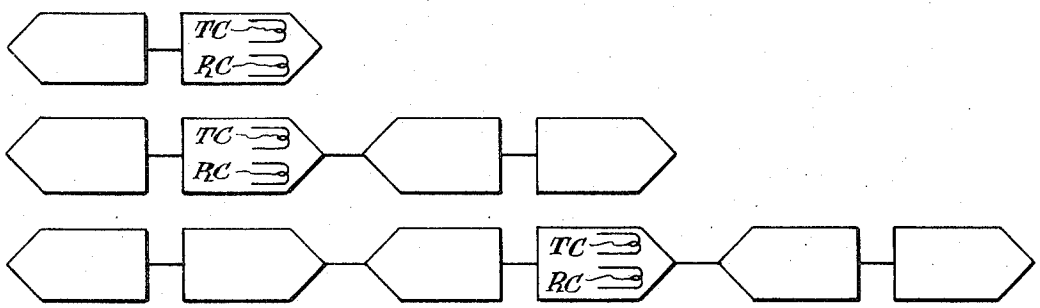


Fig. 3.

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STATION STOP CONTROL ARRANGEMENT FOR SELF-PROPELLED VEHICLES

Our invention relates to a station stop control arrangement for self-propelled vehicles. More specifically, the invention pertains to a control arrangement for triggering or initiating the operation of automatic station stop apparatus on self-propelled railroad trains or equivalent vehicles moving along a fixed right-of-way.

The procedure for controlling an automatic station stop by a self-propelled vehicle requires that certain information be transmitted from the wayside to the vehicle or train. This information includes such items as a command to initiate or trigger the station stop procedure, the distance yet to go to the station, and the direction in which the train is moving, that is, whether it is approaching a station or departing from a station. Several methods for transferring signals of one type or another from the wayside to vehicles moving along a right-of-way are known and have been used in the art. Where control of station stopping procedures is involved, there are several specific requirements for the wayside to vehicle signal transmission system. First, and probably foremost, the system must assure that the train does not respond to false signals from the wayside, that is, false triggers. Further, such action should not be initiated, even with valid signals, when a train moves along the right-of-way in a reverse direction past the location of the wayside trigger arrangement. Also, the arrangement must allow data for different lengths of trains, that is, coupled vehicles, and for different stopping positions to be transmitted to the train. The first listed requirement presents special problems due to the probable presence of false triggering signals created by external causes. Such false signals are particularly prevalent in electrified transportation systems due to the interruptions and irregularities of the propulsion currents and to sparking between the wayside power source and the train pickup devices. A necessary feature, then, of any automatic station stop system is that the triggering arrangement meet all of the listed requirements to provide a reliable control system.

Accordingly, an object of our invention is an improved control arrangement for an automatic station stopping system for vehicles moving along a fixed right-of-way.

It is also an object of our invention to provide a station stop control arrangement which eliminates the false triggering or initiation of the stopping procedure due to extraneous and/or false signals.

A further object of our invention is a station stop control arrangement which includes two or more successive trigger signal locations within a predetermined distance at the point at which the station stop procedures are initiated.

Still another object of our invention is a station stop control arrangement requiring the vehicle to pass two successive trigger devices within a predetermined time or distance interval and in a preselected order to initiate the station stop program operation.

It is also an object of our invention to provide a station stop control arrangement for vehicles which includes a first pair of spaced and distinct trigger devices which cooperate with vehicle-carried apparatus to initiate the station stop program and similar trigger

devices located along the approach track within the original distance in order to actuate a modification of the station stop control in accordance with the train performance during the stopping program.

Yet another object of the invention is a station stop control arrangement in which the vehicle-carried apparatus must respond in a preselected order and within a preset gating interval to two distinct and successive triggering devices located along the right-of-way in order to initiate the station stop program for the vehicle.

A still further object of the invention is a station stop control arrangement in which the train-carried apparatus initiates the station stop program only in response to successive and distinct signals received from wayside devices within a preset time interval and which modifies the program progression to increase the accuracy of the stop in response to a second reception of one or another of similar signals selected in accordance with the train length.

Other objects, features, and advantages of the invention will become evident from the following specification when taken in connection with the accompanying drawings and appended claims.

In the practice of our invention, pairs of wayside devices, each one of a pair having a distinctive characteristic different from the other, are positioned along the vehicular right-of-way, each location being a preselected distance in approach to the station at which stops are made. Each vehicle, normally a coupled train set, carries apparatus which responds in a distinctive manner during passage by each wayside device in accord with the particular characteristic of that device. Normally each train has two sets of apparatus, each responding only to wayside devices having a particular one of the two distinctive characteristics. Each train apparatus unit produces an output signal whenever the train passes the corresponding device if preselected conditions are met. In the specific showing herein, the wayside devices are coils tuned to one or the other of two distinct frequency characteristics. The coils of each frequency characteristic are alternately located along the stretch of right-of-way. Each set of train-carried apparatus includes a tuned transmitter-receiver unit which responds to passage by the wayside coil having the same frequency characteristic to produce an output signal, unless the train-carried apparatus is otherwise inhibited from such operation.

Gating means are interposed in the train-carried apparatus to normally inhibit the second frequency set from responding to the corresponding wayside coils. The response of the first frequency set of train apparatus upon passage of the corresponding wayside coil opens this gating means for a predetermined interval, established by time or distance measurements. If the second frequency wayside coil is passed during this interval, an output signal is produced by the corresponding train-carried apparatus. This second output signal is applied to trigger or initiate the station stop program, that is, it activates the station stop control apparatus on that particular train.

The station stop apparatus is programmed to stop the vehicle or train at the next station in advance in accordance with a preset deceleration program and a preselected stopping point. To increase the accuracy of

the station stops in accordance with predetermined desired stopping conditions, and especially where different length trains are used, at least one additional set of wayside coils is provided in the approach between the initial set and the actual station location. The second set is spaced apart in accordance with predetermined conditions of train lengths. The train apparatus is also provided with a selector arrangement to establish the train length character effective for that particular train, specifically shown as being a first or second train length condition. The response of the first or second frequency apparatus on the train is then used, that is, the output signal is applied in accordance with the train length selection, to modify the stopping program in accordance with the train deceleration performance to that point.

We will now describe in greater detail an arrangement embodying the features of our invention and then shall point out the novelty thereof in the appended claims, referring in the description to the accompanying drawings in which:

FIG. 1 is a schematic view of a stretch of right-of-way in the approach to a station with wayside devices for a station stop system involving the features of our invention.

FIG. 2 is a diagrammatic illustration of vehicle-carried apparatus which cooperates with the wayside apparatus shown in FIG. 1 to provide the station stop control arrangement embodying our invention.

FIG. 3 is a diagrammatic illustration of the location of a portion of the vehicle-carried apparatus of FIG. 2 as used for a particular type of variable train length operation.

In each of the figures of the drawings, similar reference characters refer to similar parts of the apparatus.

Referring now to FIG. 1, a stretch of right-of-way T, over which move self-propelled vehicles, is shown by conventional single line representation. The dash line block V at the left designates such a vehicle which normally moves from left to right along the right-of-way T. An obvious specific example of such systems are rapid transit cars moving along a railroad track. It is to be expected, of course, that a plurality of vehicles V, or rapid transit cars in the example, will be coupled into train sets for actual operation and the symbol V also represents such trains. Such stretches of right-of-way T may be also used for reverse movements of the vehicles or trains, either under selected conditions or as a normal type of operation. Shown along the right-of-way at the right is a station platform, illustrated by conventional block, at which the vehicles or trains are expected to stop. For purposes of a specific description, it is assumed that the preset or desired operation requires that the center of the stopped train be spotted substantially at the center of the station platform. Of course, other degrees of stopping accuracy or conditions may be used.

Located along the approach to the station platform are pairs of wayside devices to mark the approach stretch and control the automatic station stop operation of approaching trains. The first set passed by an approaching train triggers or initiates the station stopping program and the sets closer to the station then actuate a modification of the program in order to increase or improve the accuracy of the stop. In this specific showing, each wayside device is a single coil having a selected number of turns and tuned by a capacitor to a preselected frequency characteristic. In other embodiments, each wayside device may be a transmitter tuned to provide a signal with a selected frequency characteristic for reception by the train-carried apparatus, as will be discussed shortly. ONly two pairs of coils are shown in the actual illustration as this is sufficient to illustrate our invention. The first set, that is, the trigger or initiating set, comprises the wayside coils WC1 and WC2 while the second set which actuates the modification of the station stopping program comprises the wayside coils WC1A and WC2A. Coils WC1 and WC1A are tuned by identical capacitors C1 to a first preselected frequency F1 while the other two coils are each tuned by identical capacitors C2 to the second selected frequency F2. It is to be noted that additional sets of such wayside devices, or more than a pair in each set, may be used if an increased stopping accuracy is desired or if necessary because of the number of different train lengths normally operated, but the two pairs illustrated are sufficient to describe the features of our invention.

A more specific example of the apparatus involved will be described shortly in connection with FIG. 2. However, it should be noted that the first pair of wayside coils are spaced a predetermined distance *d* from each other while the second set are spaced apart a predetermined distance *y* which is selected in accordance with the various train lengths used and will normally be different than the distance *d*. The two shorter distances *x* illustrated as extending each side of coil WC2 will be defined and described shortly. It is obvious that a vehicle V moving along the right-of-way from left to right passes the coils in succession as it approaches the station. In other words, the vehicle or train alternately passes coils tuned to frequencies F1 and F2.

Referring now to FIG. 2, the particular portion of the right-of-way T from FIG. 1 is illustrated which includes the location of the initial set of wayside coils WC1 and WC2. The vehicle V, which for example may be a train of coupled vehicles, is shown approaching along the right-of-way or track by the dash line block. The remainder of the apparatus illustrated in FIG. 2 is mounted on the illustrated vehicle V although not all shown specifically within the confines of the block representation of the vehicle. Of particular note are the two train-carried coils TC and RC which are mounted to pass in relatively close inductive relationship with wayside coils WC1 and WC2 and with other sets of wayside coils involved in the control arrangement. The specific mounting locations of the various coils illustrated is unimportant to the details of our invention, the only requirement being that the mounting be such that the train or vehicle-carried coils pass in an inductive relationship with the wayside coils. In a specific example, the wayside coils WC may be mounted between the rails of the right-of-way while the train-carried coils TC and RC are mounted on the bottom of the vehicle or car of the train.

As the specification progresses, it will become apparent to those skilled in the art that several types of apparatus are usable in order to provide the control

signals for the station stop program arrangement herein described. However, for purposes of this description, the specific type of apparatus which is assumed is similar to that disclosed in Letters Patent of the United States No. 2,828,480, issued to L. R. Golladay on Mar. 25, 1958, for Train Identification Systems. Another example of the same type of apparatus is illustrated in Letters Patent of the United States No. 2,753,550, issued to R. W. Treharne on July 3, 1956, for Vehicle Reporting Systems. In adapting the patented apparatus as a specific example herein, the wayside apparatus as specifically illustrated in the Treharne patent is used on the vehicle V and the tuned vehicle coils shown in the Treharne arrangement are moved to the wayside as coils WC1, WC2, etc. The specific references for the train-carried coils TC and RC herein are taken from the Treharne patent and designate the transmitter and the receiver coils, respectively, associated with the transmitter-receiver. These coils are, of course, also similar to the coils L1 and L2 of the Golladay arrangement. The coils WC herein illustrated along the wayside of the right-of-way are similar to the coils VC in the Treharne system and coil L3 in the Golladay system. Here each wayside coil is tuned to a single preset frequency only and no selection is provided.

The vehicle apparatus is shown by conventional blocks since all elements comprise known apparatus and any one of several types may be used. A transmitter-receiver unit for each frequency is shown by the two blocks designated as the F1 and F2 transmitter-receiver units. Reference has already been made to the Golladay and Treharne patents for specific examples of such apparatus. In the present state of the art, these units are preferably designed to include solid state circuitry, but such redesign is not involved in the specific features of our invention. The transmitter-receiver units are connected in multiple to the single set of train-carried coils TC and RC. A gating means or circuit arrangement, conventionally shown by the block designated Gate 1, is interposed in the connections from coil RC to the F2 transmitter-receiver. Any known type of gating circuit having a set or open gate input and a reset or closed gate input may be used. A similar gating means represented by the block designated Gate 2 is connected into one of the leads from the output of the F1 transmitter-receiver. If desired, Gate 1 may be alternately connected in the output lead from the F2 transmitter-receiver, as will become apparent from the subsequent description.

It will be understood that, if the wayside devices are transmitters providing distinctive signals for pickup by the train apparatus, receiver units only are used tuned to respond to the frequency signals from the wayside and the train coils are connected to receive the signals in proper form. The train apparatus may include a separate receiver unit tuned to each frequency or a single unit broadly tuned to respond to all frequency signals from the wayside. In either case, a distinctive output signal is produced on the train when each wayside device is passed by the train pickup coils. Such modifications of the illustrated apparatus will be apparent to those skilled in the art and such embodiments are included as part of our disclosure.

The inputs to the two control connections of Gate 1 at times come from an interval measurement unit illustrated by the conventional block, so designated, shown below the F1 transmitter-receiver. Various types of known apparatus can be used for this purpose, the only requirement being that, during a preset interval measured following a single input pulse, two successive output signals are provided. This establishes a preset interval of time subsequent to the input to this interval measurement unit received from the F1 transmitter-receiver when the train passes a wayside coil WC1. As mentioned, these first and second signals from the interval unit are applied to the set and reset inputs, respectively, of Gate 1. This interval of time during which Gate 1 is thus opened to pass signals from coil RC is represented by the successive gating distance x shown on each side of coil WC2 in FIG. 1. One type of apparatus which may be used to measure this interval is a timing unit, such as a monostable multivibrator or a bank of counters. Such a timer unit produces the two gating pulses in accordance with the known average speed of the various vehicles V so that each vehicle is normally occupying a point within the range $x - x$ during the gating interval in order to allow the F2 transmitter-receiver to respond during the inductive relationship of coils TC and RC with wayside coil WC2. Alternately, this interval measurement unit may be a distance measuring device, for example, a counter and wheel tachometer, which produces gating pulses when the vehicle has traveled two preset distances after the unit is activated by the signal from the F1 transmitter-receiver. These distance pulses occur and activate Gate 1 only while the train is within the selected gating distance range, i.e., the preset distance x on each side of coil WC2.

As is more fully explained in the previously mentioned reference patents, when the vehicle coils TC and RC pass in inductive relationship to a wayside coil WC, the correspondingly tuned transmitter-receiver unit produces an output signal. For example, when vehicle V passes coil WC1, the F1 transmitter-receiver produces an output at the circuit connection shown at the bottom of the conventional block. Forgetting for the moment the effects of Gate 1, a corresponding output signal is provided by the F2 transmitter-receiver when the vehicle passes wayside coil WC2. These output signals from the transmitter-receivers are applied, in various manners to be discussed shortly, to a Station Stop Program Controls unit SSP. This apparatus is shown by a conventional block since various types of stop program control apparatus are known in the vehicle control art. For example, the apparatus may be adapted from that shown in Letters Patent of the United States No. 3,188,463, issued to C. M. Hines on June 8, 1965, for Brake Control Apparatus for Unmanned Trains. The requirement herein is that, with a proper input signal to unit SSP at the upper input connection designated "initiate program," the predetermined station stop program is initiated to control the propulsion means of vehicle V to stop the vehicle or train at a station a known distance in advance. A second and later input at the SSP connection designated as "modify program," occurring at a known lesser distance to the station, modifies the station stop program, in accordance with the performance of the train between the program initiating and modifying points along the stretch, to improve the accuracy of the

actual station stop in fulfilling the preselected position requirements. The patent system cited above may be adapted to this operation by controlling either or both of the relays 22 and 23 to operate when the train passes the subsequent program modification points along the right-of-way, rather than the illustrated control by the internal slow release characteristics of each relay. This allows the station stop program to be modified on a space or distance basis rather than a straight time basis. If only a single modification location is used, the patented system would incorporate only a single relay such as 22. Obviously other types of stop program apparatus may be adapted for use with our invention.

The final item of apparatus carried on the vehicle is a train length selector means TLPB, shown as being a push-pull stick type push button device, but any two-position circuit selector is of course usable for this purpose. As illustrated, circuits are normally completed through contacts 1A and 1B of the push-pull device TLPB to select a first predetermined condition of train length. In the other position of the device, circuits are completed through contacts 2A and 2B to establish a second length condition. As illustrated by the conventional symbol used, the push-pull device remains in the position to which it was last actuated until it is returned to the other position by a reverse procedure. This length selection is provided to increase the accuracy of the assumed center train, center platform station stop requirement and is correlated with the selected distance *y* between the second set of wayside coils WC1A and WC2A illustrated in FIG. 1.

We shall now describe the operation of the embodiment of the invention illustrated in FIGS. 1 and 2 for a multi-unit train, that is, a plurality of vehicles coupled together into a train set. In designing a specific installation of this embodiment, certain operating conditions must be established or at least assumed. In the following description, the first such assumption is that nearly all of the trains operating along the illustrated right-of-way have one or the other of two predetermined lengths, that is, include a predetermined number of vehicles coupled together. It is also a condition that the train coils TC and RC at the front of the train, that is, located on the lead car, are the only ones active on these trains to control the apparatus. As previously mentioned, the requirement may be preset that the train is to stop with its center at the center of the station platform, although the description will make it obvious that any point of stopping may be preselected.

Referring first to FIG. 1, coils WC1 and WC2 are located at a predetermined distance in the approach to the illustrated station in accordance with the preset stopping control program. The distance *d* at which these coils are spaced is established in accordance with the average train speed at this location and the characteristics of the interval measuring device used on the train. This will result in Gate 1 being opened, as controlled by F1 transmitter-receiver, at the time during which the train coils are within the distance range $x - x$ on either side of coil WC2. The second set of coils WC1A and WC2A are located as required by the stopping program to allow sufficient remaining distance to modify the stopping procedure in accordance with preceding train performance. The distance *y* is fixed proportional to the difference between the two train lengths which nearly all of the trains will have. For example, the distance *y* may be equal to one half of the difference between the two principal train lengths used in this system.

Referring now more specifically to FIG. 2, we assume that the train length involved is a first condition so that push button TLPB remains in the position illustrated. The positioning of this device TLPB to select between the two train length conditions is accomplished, in accordance with the known length, by the attendant who is assigned to ride on the train, or by the crew at the yard where the train was made up prior to its dispatch along the right-of-way. For the present assumption, if push button TLPB had not been in its first position, it would be so placed by pulling the operating arm. When the train or vehicle V passes wayside coil WC1, the train coils TC and RC are placed in inductive relationship to the wayside coil and the F1 transmitter-receiver unit produces an output signal, as explained in detail in the previously mentioned patents of Golladay and Treharne. This output signal appears on the lead at the bottom of the F1 block and is applied to the interval device. Since Gate 2 is presently closed, that is, in its circuit interrupting condition, there is no passage of this signal along the multiple path through Gate 2. Actuated by this signal, the interval unit operates to supply the successive signals from its output leads in accordance with the characteristics preselected. The initial signal is applied to the set input for Gate 1 and the second signal, at a predetermined time interval later, to the reset input circuit. The application of this reset pulse to the corresponding input of Gate 2 is immaterial at this point in system operation. Gate 1 is thus opened, that is, in its circuit completed condition, for this time interval during which the train coils should be within the distance range $x - x$ of FIG. 1.

If train V passes coil WC2 during this gate open period, coils TC and RC, being in an inductive relationship with coil WC2, actuate the F2 transmitter-receiver to respond to the tuned wayside coil to produce an output signal at the connection at the right side of the conventional block. This output signal from the unit F2 is applied to the "initiate" input lead of the Station Stop Program Controls apparatus SSP. Unit SSP then controls the propulsion and/or braking apparatus of the train in a predetermined manner to stop the train at the station with, as will be explained, a later modification which may be required to improve the accuracy. It should be noted that whether or not contact 2A of device TLPB is closed, this initial first output from the F2 transmitter-receiver unit is only effective on the "initiate" input lead due to the internal operation of unit SSP.

If transmitter-receiver F1 is actuated by a false signal, due to some external cause, at some other location along the right-of-way, train V will not be passing wayside coil WC2 during the gating interval produced by the interval unit. Since there will be no wayside coil WC2 to inductively react with the train-carried coils, the F2 transmitter-receiver is not actuated and there is no trigger pulse to initiate the station stopping program of the train. If the coils TC and RC are actuated at some other location in any manner by an external cause to produce a false F2 signal or relationship, the closed condition of Gate 1 prevents the false actuation of the

F2 transmitter-receiver and no "initiate program" signal is incorrectly applied to unit SSP. It is also improbable that successive false signals simulating frequencies F1 and F2 from wayside coils WC1 and WC2 will be induced in coils TC and RC within a proper time or distance interval to cause Gate 1 to be open when the false F2 signal occurs so that the F2 transmitter-receiver will be incorrectly actuated. It will also be obvious that, if the train is moving in the opposite direction along the right-of-way so that it passes wayside coil WC2 prior to its passage of coil WC1, Gate 1 is not open when the train passes coil WC2 and the F2 transmitter-receiver unit therefore cannot respond to the inductive relationship between the train coils and the wayside coil. Thus the arrangement has a direction selection automatically built into the operation and the station stop is not initiated unless the train is moving in the direction toward the station area. Said in another way, the train must be moving in the proper direction and pass a set of wayside coils WC1 and WC2 within a proper time interval, producing both output signals, in order to initiate the station stopping program. Under no other conditions will the program be initiated.

We return now to a train which has properly operated the two transmitter-receiver units within the correct time interval so that the station stop program has been initiated. When this train passes coil WC1A, the same output is produced by the F1 transmitter-receiver as when the initial wayside coil was passed. The interval measurement is again actuated, providing during the preset interval the set and reset signals to Gate 1, but at this time these are immaterial to the system operation. The F1 unit output signal is also applied to Gate 2 which, under the influence of the set signal received from the station stop program apparatus SSP, is in its open or circuit completed condition. As indicated by the legend, this signal is provided by unit SSP whenever a program is active to stop the train and the circuit is completed over contact 1B of push button TLPB to the set input of Gate 2. The signal from the F1 unit is thus applied through Gate 2 and over contact 1A of device TLPB to the "modify program" input of unit SSP. It will be noted that Gate 2 is held in its open condition by the set signal from unit SSP even though the brief reset signal from the interval unit associated with the F1 transmitter-receiver is applied to the reset input of Gate 2. The "modify" signal input to unit SSP causes the active station stopping program to be modified, in accordance with the train performance to that point, to increase the accuracy of the specific stop at the station platform. It will be further noted that Gate 1 is open for the same time interval as when the train was passing coils WC1 and WC2. Gate 1 is not under these conditions affected by the "program-active" signal from unit SSP since contact 2B of push button TLPB is open. The F2 transmitter-receiver may or may not be actuated by the passage of the train by coil WC2A depending upon whether the predetermined distance *y* relatively corresponds to the distance *d*. However, the operation of the F2 transmitter-receiver at this time is immaterial since any possible output would be ineffective, i.e., blocked from reception by unit SSP by open contact 2A of selector TLPB. Thus the station stopping program for this particular train was initiated as the train passed coils WC1 and WC2 within the predetermined gating interval and was later modified in accordance with the preset train length condition as the train passed the location of coils WC1A and WC2A, resulting in a stop by the train at the center of the station platform.

If the train in question has a second condition length so that device TLPB is set in its position 2, there is no change in the previously described action as this train V passes the location of coils WC1 and WC2. The eventual output from the F2 transmitter-receiver is applied to the "initiate" input of unit SSP and the stop program is triggered and proceeds. When the train passes coil WC1A, the F1 transmitter-receiver responds as before and the interval measurement unit produces its gating signals. The output signal from the transmitter-receiver F1 is blocked at Gate 2, however, since this gate has not been set to its open position because contact 1B of length selector TLPB is open to interrupt the "program-active" signal application. However, the "program-active" signal is applied over contact 2B of device TLPB to the set input on Gate 1 to hold this gate in its open or circuit completed condition throughout this stopping period. Thus, when train coils TC and RC pass wayside coil WC2A, the F2 transmitter-receiver is actuated since Gate 1 is open and an output signal is produced. This output signal is applied over contact 2A of device TLPB to the "modify" input of unit SSP. Thus the station stop program is not modified until the train reaches the location of the second coil of the second set, that is, coil WC2A. This is proper since the second condition is a longer train length and requires that the modification occur at a later time in order for the desired stop position to result. Regardless of any reset signals which may be applied to the two gates during the passage of the train along the right-of-way, each gate is positively reset to its blocked or closed condition by the reset signals from unit SSP when the vehicle has actually stopped at the station.

If more than two lengths of trains are normally used in the system, the arrangement of train coils such as illustrated in FIG. 3 may be used with the remainder of the train-carried apparatus of FIG. 2 to assure that the modifying signal for the station stop program is applied at the proper time. Each line of FIG. 3 represents a different length train, with the assumption that a train is made up from married pairs of cars. This term married pairs designates a semi-permanently coupled pair of cars, as shown in the top line of FIG. 3, which has only one complete set of operating apparatus, including this station stop control arrangement. During the makeup of a train of this type, the set of train coils TC and RC nearest the center of the assembled train is made active, that is, made to be the controlling set of train-carried coils. It is this active set of coils TC and RC which is illustrated in the various train combinations of FIG. 3. The conditioning of a set of train coils into the active state to control the train stopping programs is accomplished by the crews at the yard where the trains are made up. As indicated in FIG. 3, if an odd number of married pairs of cars is used, the active train-carried coils are separated by one car length from the physical center of the resulting train combination. If an even number of married car pairs is used, as shown in the

second line of FIG. 3, the active train coils are physically located at the train center. In addition to making a set of the coils active, if an odd number of married car pairs is used, the length selector push button TLPB at the controlling location of the station stop apparatus is set to train length condition 2, that is, contacts 2A and 2B are closed by pushing the device. If an even number of married car pairs is used, the device TLPB at the control location is set to condition 1.

In connection with this arrangement, the wayside distance *y* shown in FIG. 1 between the second set of wayside coils is fixed at the length of a single car, not a married pair but a single car. The operation of the train-carried apparatus, as described previously, depends upon the position of push button TLPB. When the train includes an even number of married pairs, as illustrated by the middle line of FIG. 3, the modifying control on unit SSP is applied when the active TC, RC coils pass wayside coil WC1A. Since these train coils are at the center of the train, this is proper to obtain a center of the station platform train stop. If the train is composed of an odd number of car pairs, such as in the top and bottom lines of FIG. 3, the modifying control occurs when the train coils pass wayside coil WC2A. The middle of that train is then opposite coil WC1A so that the same stopping distance to the station is in effect for the center of the train. It will be obvious from the immediately preceding description that, if married pairs of cars are not used but individual cars are assembled into various length trains, a similar arrangement of making active a particular set of train-carried coils TC and RC will result in the same type of operation.

The arrangement of our invention thus provides a station stop program control which assures that action is initiated only when valid signals are received on the train from the wayside devices. The arrangement further provides for modifying the stop program process to improve the accuracy of the final stop at the station in accord with the train performance over a selected length of the track and in accordance with a preselected train length condition. In this manner, the stopping accuracy of different length trains operating over the same right-of-way can be held within the same minimum distances. The desired result is obtained by using conventional apparatus arranged in accordance with the features of the invention and operating as described herein. The arrangement is reliable and eliminates both false operation from improper wayside signals and the initiation of the stop control on trains operating in the reverse direction along the right-of-way. An improved, desirable, and accurate type of station stopping control is thus achieved.

Although we have herein shown and described but one complete arrangement of a station stop control arrangement for self-propelled vehicles, it is to be understood that various changes and modifications within the scope of the appended claims may be made without departing from the spirit and scope of our invention.

Having thus described our invention, what we claim is:

1. A station stop control arrangement for a vehicle having propulsion and braking apparatus and moving on a fixed right-of-way along which are located stations at which said vehicle is to stop, comprising in combination,

a. an initial set of first and second wayside means positioned in spaced relationship along said right-of-way at a preselected location in approach to each station, each means of a set having a distinctive characteristic,

b. at least one other set of said first and second wayside means positioned in spaced relationship along said right-of-way at another selected location closer in approach to each station,

c. first and second signal means on said vehicle, each uniquely responsive to passage by a first and second wayside means, respectively, for producing an output signal,

d. a station stop program control means on said vehicle control by said second signal means and operable when initially activated by an output signal from that signal means for controlling the vehicle propulsion and braking apparatus to stop the vehicle at the next station in advance along said right-of-way,

e. a first gating means on said vehicle connected to normally inhibit response by said second signal means to a second wayside means,

f. an interval measurement means on said vehicle controlled by said first signal means for establishing a predetermined interval subsequent to said first signal means output signal,

g. said interval measurement means connected for activating said first gating means only during said predetermined interval to permit said second signal means to respond to a second wayside means,

h. said station stop program control means further controlled selectively in accordance with a preset vehicle length condition by said first or second signal means during response to each other set of wayside means for modifying the established train stop program in accordance with vehicle propulsion conditions existing when that additional set is passed by said vehicle, and

i. a second gating means controlled by said program control means and connected for inhibiting control of said program control means by said first signal means except when a station stop program has been previously activated.

2. A control arrangement as defined in claim 1, in which said interval measurement means is a timing device which establishes said predetermined interval beginning a timed delay period after said first signal means output signal preselected in accordance jointly with the average speed of vehicles at and the spacing between said initial set of wayside means so that each vehicle passes the initial second wayside means during said predetermined interval.

3. A control arrangement as defined in claim 1, in which said interval measurement means is a distance measurement device jointly responsive to a first signal means output signal and the movement of that vehicle along said right-of-way to establish said predetermined interval when that vehicle has moved a preselected distance, at which the initial set of wayside means is spaced apart, beyond the location of a first wayside means so that said vehicle passes the second wayside means of said initial set during said predetermined interval.

4. A control arrangement as defined in claim 1 for a plurality of said vehicles operating along said right-of-way coupled into a train having one or the other of two predetermined train length conditions and only one active set of said first and second signal means, the combination further including,

a. a train length selector means on said train associated with said active set of signal means and selectively operable to a first and a second position in accordance with a first or second length condition of said train,

b. a circuit network connected between said program control means and both said gating means and controlled by said length selector means for activating said second or said first gating means in accordance as said length selector means is operated to its first or second position, respectively, when said program control means has been previously activated,

c. another circuit network also controlled by said length selector means and connected for supplying to said program control means, when said train passes an additional set of wayside means, the output signal produced by said first or second signal means in accordance as said length selector means is operated to its first or second position, respectively,

d. said second gating means interposed in said other circuit network for inhibiting the supply of the output signal from said first signal means to said program control means except when said program control means is already activated.

5. A control arrangement as defined in claim 1, for a plurality of said vehicles coupled into a train having one or the other of two predetermined train length conditions and only one active set of said first and second signal means, which further includes,

a train length selector selectively operable to a first and a second position as the corresponding train has a first or a second length condition, respectively,

b. a first circuit including a first position contact of said length selector and said second gating means and connected for at times supplying the output signal of said first signal means to said program control means to modify the stopping program when the train passes an additional set of wayside means,

c. a second circuit including a second position contact of said length selector and connected for at times supplying the output signal of said second signal means to said program control means to modify the stopping program when the train passes an additional set of wayside means,

d. a third circuit including another first position contact of said length selector and connected for supplying at times from said program control means only while activated an activating signal to said second gating means,

e. a fourth circuit including another second position contact of said length selector and connected for supplying at times from said program control means only while activated an activating signal to said first gating means,

f. a reset circuit connected to said first and said second gating means from said program control means for supplying when the train has stopped a reset signal to deactivate any previously activated gating means.

6. A control arrangement as defined in claim 4 in which,

a. said initial set of first and second wayside means is spaced apart a first distance preselected in accordance with the time of occurrence of said predetermined interval, so that said train will pass said second wayside means of that initial set during said predetermined interval,

b. each additional set of first and second wayside means is spaced apart a second distance proportional to the difference in the length of trains having first and second length conditions.

7. A control arrangement as defined in claim 6, in which said interval measurement means is a timing device which establishes said predetermined interval beginning a timed delay period, after an output signal from said first signal means, preselected in accordance with the average speed of trains at and the spacing between the initial set of first and second wayside means so that each train passes the initial second wayside means during said predetermined interval.

8. A control arrangement as defined in claim 6, in which said interval measurement means is a distance measurement device jointly responsive to an output signal from said first signal means and the movement of that train along said right-of-way to establish said predetermined interval when that train has moved a preselected distance, at which the initial set of wayside means is spaced apart, beyond the location of a first wayside means so that said train passes the second wayside means of said initial set during said predetermined interval.

9. A control arrangement as defined in claim 6 in which,

a. each first and second wayside means comprises a coil tuned to a first or a second distinctive frequency characteristic, respectively,

b. each first and second signal means is a transmitter-receiver pretuned to respond only at said first or second frequency characteristic, respectively,

c. each set of said first and second transmitter-receivers is coupled during movement of that train along said right-of-way to each successive wayside coil, a particular transmitter-receiver responding to produce an output signal only when the coupled wayside coil is tuned to the corresponding frequency characteristic.

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