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[54] **HUMP YARD RETARDER CONTROL SYSTEM**

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[52] **U.S. Cl.** .... **246/182 A,** 444/1
[51] **Int. Cl.** **B61k 7/12**
[58] **Field of Search** .... 444/1; 246/182 A

[56] **References Cited**

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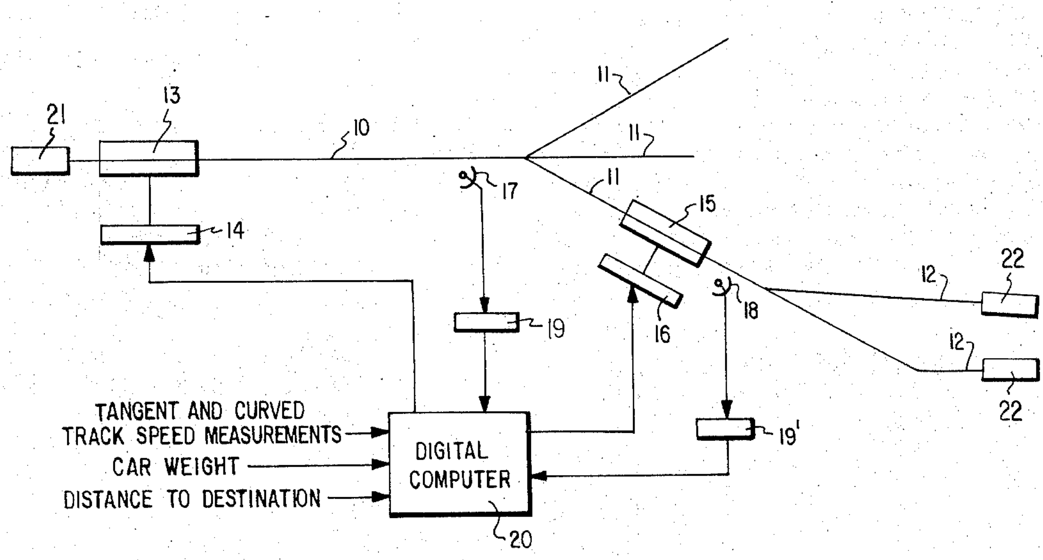
[57] **ABSTRACT**

A system utilizing an algorithm and associated digital computer program for controlling a hump yard retarder to release freight cars from the retarder with a predetermined exit speed. The algorithm accepts successive measurements of car velocity during the time the car is in the retarder, and a specification of the desired retarder exit speed, and computes digitally an effective sequence of retarder operating commands, to smoothly decelerate the car to the desired final speed. Feedback through successive speed measurements is employed to ensure accurate exit speed control over a broad range of car weights and rollabilities. The deceleration is smoothed over the length of the retarder to avoid excessive wear on the leading end of it. The algorithm ensures that the retarder will be open at car release if the final speed has been reached.

6 Claims, 7 Drawing Figures



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4 Sheets-Sheet 1

FIG. 1

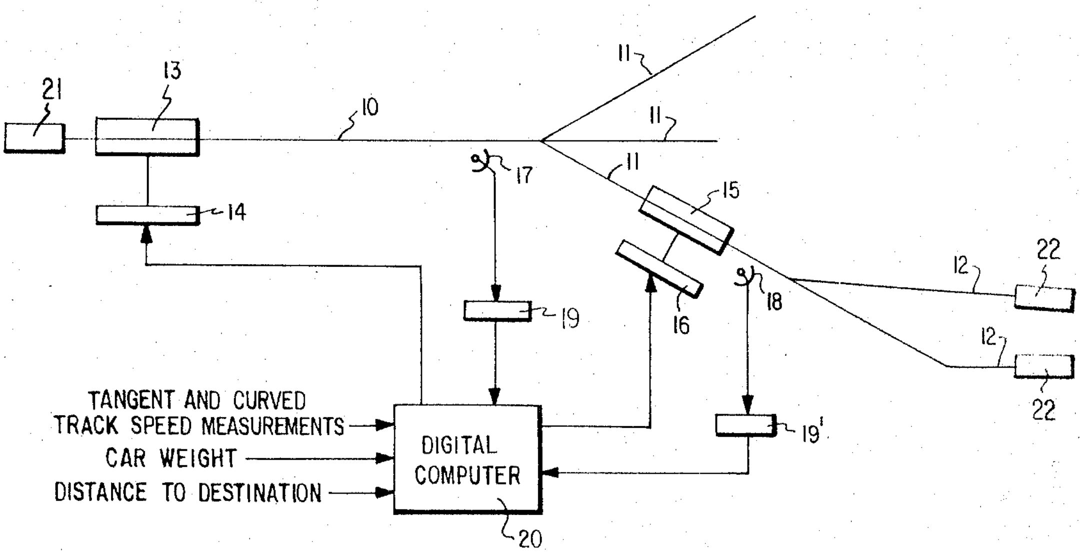
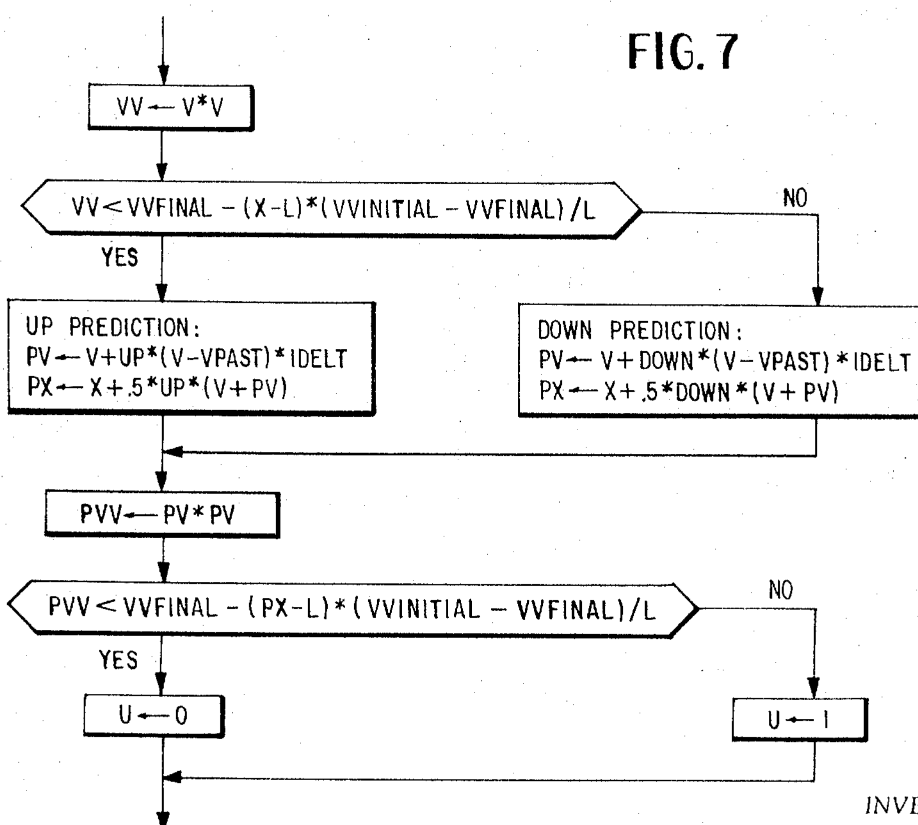


FIG. 7



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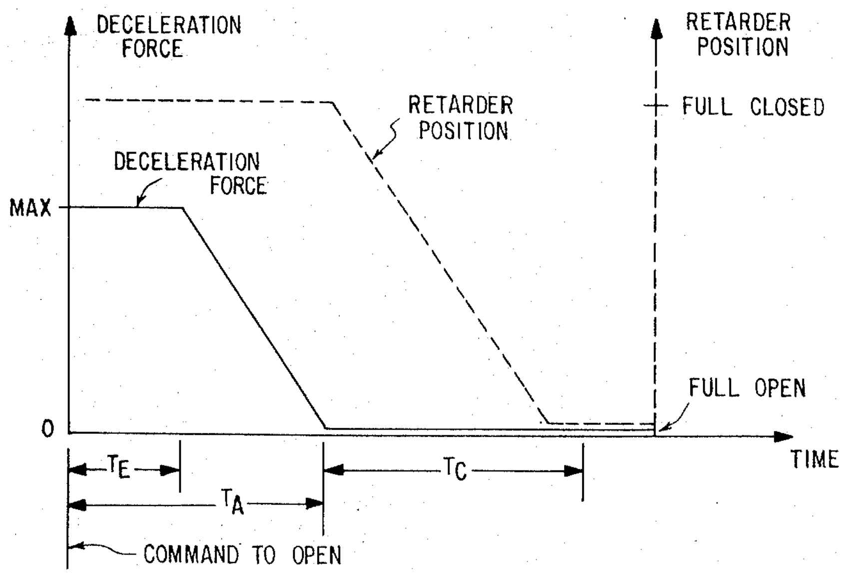

FIG. 2

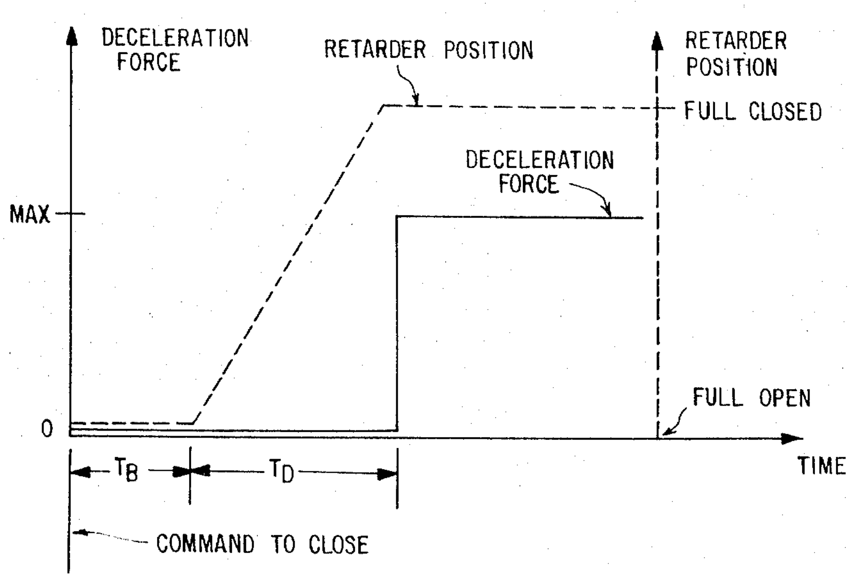

FIG. 3

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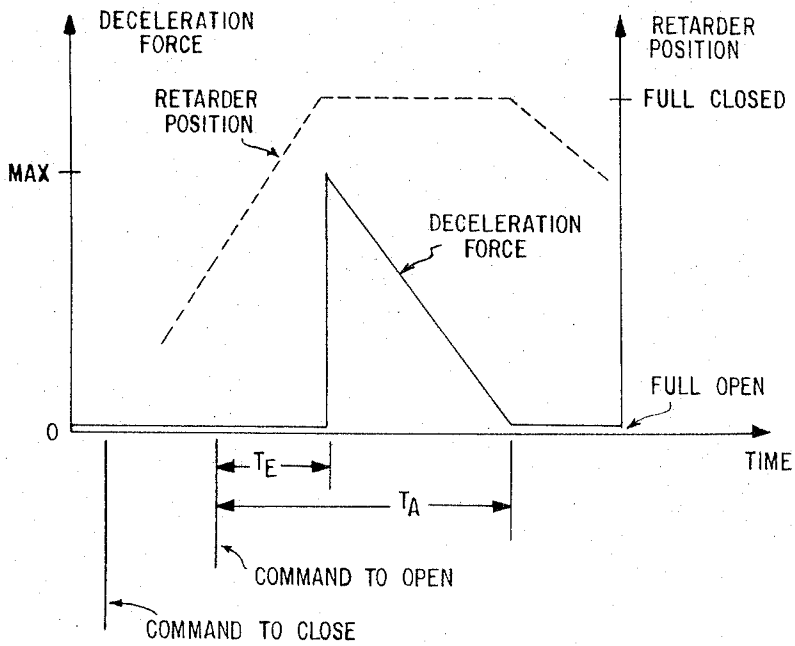

FIG. 4

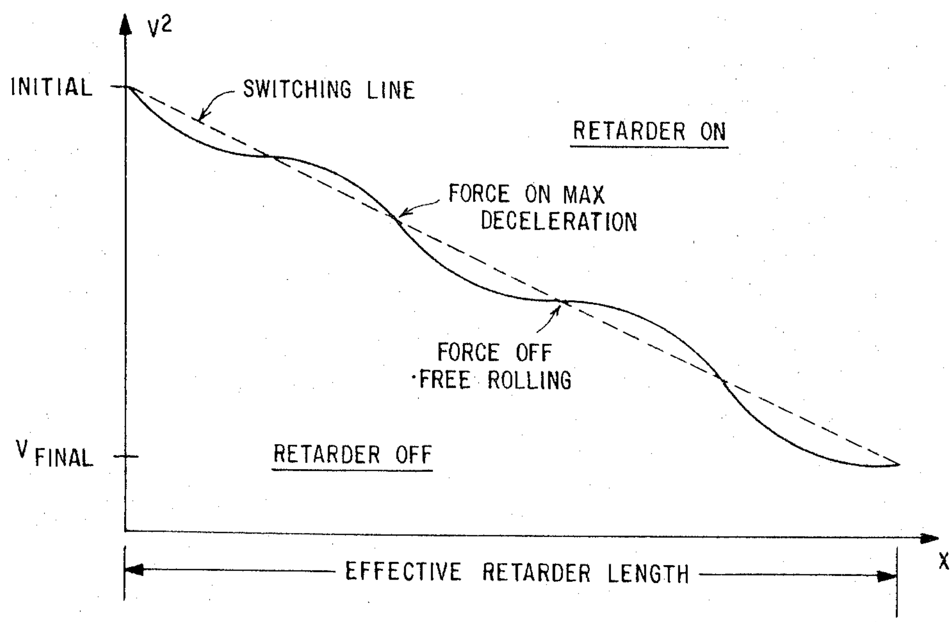

FIG. 5

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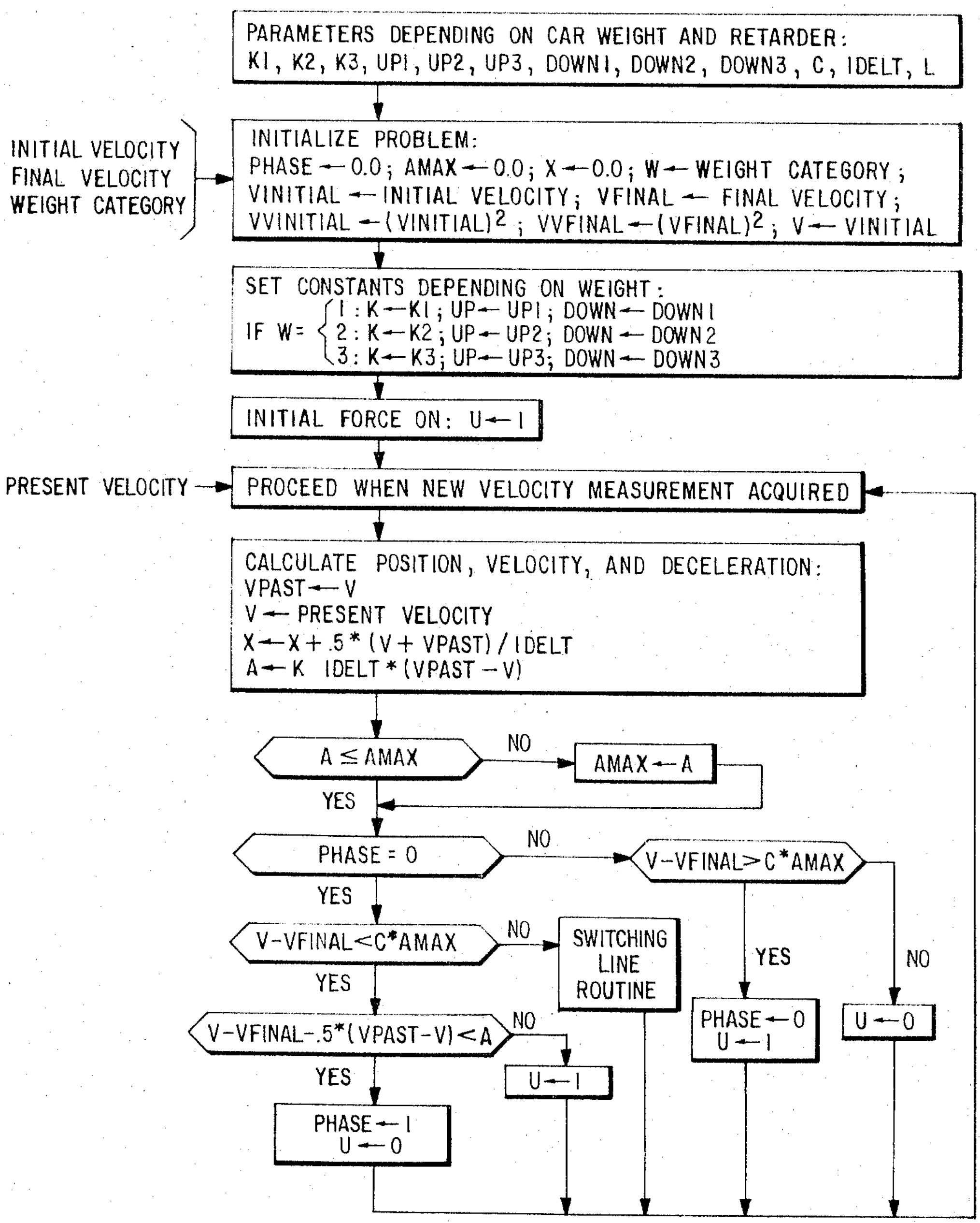

FIG. 6

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HUMP YARD RETARDER CONTROL SYSTEM

BACKGROUND OF THE INVENTION

The present invention relates to a railway car classification yard and more particularly, to means for controlling the retarders used in the yard so that cars passing through the retarders are decelerated at a uniform rate and are released from the retarders with a predetermined exit speed.

During the movement of railway cars over the railway system of the country, it is necessary, in most cases, to classify cars according to destination so that the cars can be properly placed in a train which is being made up. Classification yards are used for this purpose and such yards generally include a hump over which the cars are pushed and then allowed to roll, under the influence of gravity, down a main track leading from the hump.

After rolling down the main track, the cars are switched by an automatic switching system from the main track to a plurality of branch tracks and then over additional switches to a preselected final destination track.

One or more car retarders are located along the main track, and are designated as "hump or master retarders." Additional car retarders known as "group retarders" are included in the branch tracks as well, so that the speed of each car can be retarded or controlled according to the particular conditions on the tracks over which it will travel.

The retarders generally comprise side rails which are disposed along both sides of the rails of the track and these side rails can be moved into and out of contact with the wheels of the cars that pass along the track at the retarder location. Generally this movement of the retarder side rails is accomplished by means of a pneumatically operated mechanical system. These systems respond to the commands to apply retarding force or to release such force when pneumatic cylinders, that are mechanically coupled to the side rails, are pressurized and evacuated respectively.

In modern classification yards, apparatus is provided for automatically controlling the operation of the various retarders with the objective of causing each car to reach its intended destination with a preselected coupling speed. The term "coupling speed" is used to describe the car speed at the instant that the car, while traveling down its preselected destination track, encounters or engages the stationary cars that are already stored on that track. If the cars are not retarded sufficiently, excessive impacts result and frequently cause damage to the car or the lading. On the other hand, if the cars are retarded too much, excessive space in between cars results and this causes inefficient utilization of trackage. Furthermore, it is conceivable that the cars can be retarded to such an extent that they do not actually reach and couple with the cars on the destination track.

In order to obtain a preselected coupling speed, a control system for the retarders is used which automatically controls the retarders with the object of causing each car to leave a retarder with a predetermined exit speed such that it will couple with cars on its destination track at the preselected coupling speed. Obviously the exit speed at which a car leaves a retarder is quite critical and has been found that this speed will vary

from car to car and with resPect to conditions existing in the classification yard.

There are control systems for retarders now in use that utilize computers to compute the exit speed from a retarder. The computer receives information with respect to each car approaching the retarder and this information generally includes car weight, speed measurements frOm which the rollability factor for the car can be determined and the distance the car must travel from the retarder to couple with the car on a destination track.

In a typical installation, cars pass first through a master or hump retarder which is controlled so as to achieve a rather uniform spacing between cars after they leave the retarder and continue rolling down the main track. Toward the lower end of the main track a number of branch tracks extend down the hump and these branch tracks lead into the various destination tracks.

As a car nears the master retarder, and before it reaches a group retarder on a branch track over which is destined to pass, it moves over a weight test section in the main track designed to determine the cars weight classification within the light, medium and heavy range. This information is transmitted to a computer as one factor in determining exit speed requirements for the group retarder. In addition the information is transmitted through suitable signal means to solenoid valves, associated with the retarder control mechanism for the group retarder pneumatically operated mechanical system, in order to control the pressure used in the retarder for that paricular car weight.

Also as the car proceeds towards a group retarder, speed measuring means, such a radar, follows its progress through a tangent section of track and a curved section of track. This information is fed by suitable signal means to the computer for a determination of the rollability factor for this car.

Meanwhile the computer is also receiving a signal from a track circuit on the destination track for which the car is heading. This signal for indicating track occupancy is a measure of distance from the group retarder to the train being assembled on that particular destination track.

From this information sent to the computer, the computer can compute the desired exit speed of this car from a group retarder so that the car will couple at a preselected coupling speed with the last car of the train. The computer signals the retarder control mechanism of the group retarder for that branch track to apply pressure to move the side rails of the retarder against the car wheels to slow down the car. During this slowing down process the computer is receiving signals from the radar unit monitoring the cars progress through the retarder and signals the retarder to open the side rails at the appropriate time to release the car from the retarder when the car is moving at its predetermined exit speed.

Generally a retarder control system of the type described above is effective to achieve the desired exit speed of the car in the retarder and its release at this speed. However, in the presently used systems all of the deceleration of the car tends to occur in the initial portion of the retarder. This results in more frequent maintainance work on the retarder because of uneven wear in the retarder side rails. Furthermore, there is a lower throughput of cars through the retarder because of the lower average velocities of the cars.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide a retarder control system in which the predetermined exit speed of a car from a retarder is achieved with a more constant deceleration profile than that obtainable in presently known systems.

It is also an object of the invention to provide a retarder control system to ensure that the retardation of the car is achieved throughout the full length of the retarder.

According to the invention, a digital computer, which has been programmed to accept a plurality of input signals and determine an exit speed for a car from a retarder in a classification yard, is also programmed on the basis of a digital control algorithm, to issue a series of commands to a retarder control system so as to insure a more uniform deceleration of the car within the total effective length of the retarder.

The computer receives a series of signals from a speed measuring device, such as radar, which is monitoring the speed of the car as it passes through the retarder. Each speed measurement is utilized in the computer to determine whether a projected speed of the car ahead of that position where a measurement is taken is above or below the speed of the car which the car should have if it was being decelerated at a straight line uniform rate from its entrance speed into the retarder to a desired exit speed from the retarder. If the projected car speed is above that which is required for uniform deceleration, the computer initiates a signal to the retarder control mechanism to close the retarder to brake position and conversely if the projected speed is below that required, the retarder is opened to a non-braking position.

The computer is programmed to take into account the time delays that are inherent in executing the commands to open and close the retarder. In addition, the algorithm and its associated program for the computer is set up to ensure that as the car speed approached the computed exit speed, the retarder is commanded to open with a sufficient lead time so that when the predetermined exit speed is reached, the retarder is in an open position.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows diagramatically a portion of the track layout of a typical railroad car classification yard with the retarders and associated systems indicated in block and symbol form.

FIG. **2** is a graph showing the opening action of a railroad car retarder, with the resultant deceleration force applied to the car, as plotted against time.

FIG. **3** is a graph showing the closing action of a railroad car retarder, with the resultant deceleration force, as plotted against time.

FIG. **4** is a graph showing both opening and closing actions of a retarder plotted on the same scales as FIGS. **3** and **4.**

FIG. **5** is a graph showing a uniform deceleration line for a car in a retarder together with an on-off action line of the retarder and with both lines plotted against $(speed)^2$ and time.

FIG. **6** shows an overall flow chart of the algorithm according to the invention.

FIG. **7** shows a flow chart of the switching line routine of FIG. **6.**

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As seen in FIG. **1,** the track system of a railroad car classification yard includes a main track **10,** branch tracks **11,** and destination tracks **12.** A master retarder **13** is associated with main track **10** and its operation is controlled by a retarder control mechanism **14.** A group retarder **15** is associated with a branch track **11** and is controlled by the retarder control mechanism **16.**

The retarders **13** and **15** and the retarder control mechanism **14** and **16** are shown in block form in FIG. **1,** and, as this type of equipment is well known in the art, it is not illustrated in detail. However, for the purpose of disclosing this invention, mention will be made of certain basic features of such equipment.

Both retarders **13** and **15** can be of the same construction and include a pneumatically operated mechanical system having a number of pneumatic cylinders which can be selectively pressured or evacuated to move pairs of side rails into and out of engagement with the wheels of cars passing through the retarder to brake the car.

The control of the pneumatically operated mechanical systems of the retarders **13** and **15** is achieved through the retarder control mechanisms **14** and **16,** which are identical. These control mechanisms include electrically controlled pneumatic valves which on signal, permit an air flow to the cylinders of its associated pneumatically operated mechanical system or the exhaust of air from the cylinders. The pressure of the air to take care of the light, medium and heavy weight catagories of cars going through a retarder.

Speed measuring devices **17** and **18** are positioned along tracks **10** and **11** respectively to measure the speed of a railroad car as it moves down main track **10** and through the group retarder **15.** These devices, which are shown by symbol only, are radar units of well known design which utilize directional antennas and the Doppler principle. Such devices and their use is described, for example, in the Broackman U.S. Pat. No. 3,110,461, issued on Nov. 12, 1963.

The computer **20** is of the digital type and can be of a type commercially available. For example, during test runs of the present invention which were conducted at the classification yard of the Southern Pacific Transportation Co. at Eugene, Oregon, a model DDP 116, 16 bit digital computer, manufactured by CCC Division of Honeywell Co., at Farmingham, Mass., was used. The algorithm, to be described in more detail later, was programmed on this computer.

As seen in FIG. **1,** a plurality of inputs are received by the computer **20** and these inputs, which provide information from which the desired exit speed of a car from a retarder is computed, will be discussed first.

The computation of a desired exit speed of a car rolling through a retarder can be done in different ways but generally a computer which is used for this purpose receives information as to the desired speed of which cars are to couple, other information about the car itself, its expected rolling characteristics, and the distance the car must travel from the end of the retarder to a coupling point.

In FIG. 1 the computer **20**, is shown as receiving inputs relating to car speeds, weight and distance from the retarder to destination. For purposes of the present disclosure it is believed that it will be sufficient to generally describe the means involved in providing such input as such means are well known in the art.

The speed measuring device **17** monitors the speed of a car as it rolls down the hump of the yard over curved as well as straight or tangent sections of track and sends, through pulse shaping and priority interrupting circuits **19**, the tangent and curved track speed measurements to digital computer **20**. Signals which are indicative of into which of three weight catagories (light, medium and heavy) a car will fall are obtained from electrical switches associated with a weight rail **21** in the main track **10**. The distance to destination input is obtained by a suitable track occupancy circuit, shown in box form at **22**, which is closed or shorted by the car wheels and axels of the last car standing on a destination track **12**. Finally a desired coupling speed is arbitrarily chosen.

Experience has indicated that the desired exit speed can be computed in different ways but as an example the following computation proves to be very satisfactory, and can be programmed on the digital computer:

$$V_3 = Ai\ (Vcl)^2 + Bi\ (Vc2)^2 + Ci\ V_4 + Di$$

where

$$V_4 = [Ej\ (Vt_1)^2 + Fj\ (VT2)^2 + G_j]\ Si + (HjVc + Ij)$$

and in which

V_3 = desired exit speed or velocity at the group retarder
Si = measured distance to destination
Vc = desired coupling speed
V_t = speed or velocity on tangent track
V_c = speed or velocity on curved track
D = Additive adjustment factor

The arbitrary coefficients and constant terms A through I are established through multiple regression analysis of test data obtained by humping cars to each destination track. In this equation, i= coefficients for a particular destination track and the subscript j refers to the coefficients for a particular car weight class (light, medium, heavy).

The present invention is described here in conjunction with a group retarder **15** but it should be stressed that the invention can be used also in conjunction with a master retarder.

In the group retarder **15**, as previously mentioned, the speed of a car through this retarder is monitored by speed measuring device **18**. Signals from this device **18** are transmitted through pulse shaping and priority interrupt circuits, shown in box form at **19'**, to the computer **20**. The design and function of such circuits is, it is believed, well known in the art and it is sufficient to indicate that they involve a typical Schmitt trigger operation in series with the priority interrupt line provided as a feature of the computer.

As seen in FIG. **1**, the computer **20** is connected to retarder control mechanisms **14** and **16** and is programmed to issue command signals (on-off) to these mechanisms. These command signals are transmitted through a flip-flop circuit to drive a reed relay between on and off positions. The reed relay In turn controls an intermediate relay which completes the electrical circuits to the solenoid valves in the retarder control mechanism in order to pressurize or exhaust air from the cylinders of the pneumatically operated mechanical system. These circuits are knows in the art, as is the control system, and therefore are not shown on the drawing.

Before proceeding with a description of the algorithm developed for the control system, according to the invention, it is helpful to consider the fundamentals of retarder dynamics.

It will be recalled that the mechanism by which car retardatIon is affected in the retarder is a pneumatically operated mechanical system which squeezes the car wheels between two side rails. The system responds to two commands, *close* (apply retarding force) and *open* (release force), by pressurizing and evacuating a number of pneumatic cylinders which are mechanically coupled to the side rails. Response to commands is quite slow, due to the dynamics of the system. This implies that a command given on the basis of present car position and velocity will not be implemented until some time in the future, at which time the car will have a different velocity and position. Because of suc delays, an effective control system should take such account of the retarder response. To do this, a model, or mathematical description of the effect of retarder operation, must be developed.

It should be stressed that the model need not correspond to the actual physical process by which retardation is accomplished. This process is quite complicated and would require the use of a high-order nonlinear differential equation for an accurate description. What is required of a model is that it describe the relevant behavior of the retarder to a reasonable degree of accuracy. In this case the relevant behavior is the relationship of commands given to retarder force applied. The degree of accuracy required is such that errors in response times be small with respect to the dynamics of car motion.

In order to clearly illustrate this situation it is helpful to consider the deceleration force in a retarder with respect to the retarder position and relative to time.

Attention is directed first to FIG. **2** which shows the action of the retarder, which was initially in a fully closed position, after receiving a command to open. As seen there, after the command to open is received at the retarder, an interval T_E elapses before the pressure exhaust valve opens. The interval T_E is followed by a decrease in cylinder pressure (assumed linear) to the point where the springs in the mechanical system of the retarder causes the retarder to open, T_A seconds after the command. The retarder continues to open, and after an additional interval of T_C seconds the retarder reaches the fully open position.

In FIG. **3**, the action of the retarder, which is initially in a fully open position, is shown after the command to close is received by the retarder control mechanism.

The time interval between the command to close and the actual movement of the retarder is designated T_B. After T_B is an interval during which the retarder closes at an observed near constant rate. This observed constancy of closure rate implies that the force of the air pressure on the pneumatic cylinders is small compared to the inertia of the retarder and the spring force, and hence that the line pressure is reached in the cylinders before the retarder reaches its closed position. Consequently, the retarder deceleration force reaches its maximum essentially instantaneously at the time the retarder reaches its closed position. The total delay, after the interval T_B before the retarder reaches its full closed position and deceleration force is applied, is designated T_D.

Generally the response of the retarder to a command is a complex function of the present condition of the retarder. For example, if the command to the retarder is to close, the actual response of the retarder depends on whether the retarder is fully or partially open when the command is given. If the delay D is defined as the response time to the command to close, then under the assumptions discussed above, D can be described mathematically in terms of a single retarder state variable S, defined as the time between the previous command to open, and the present command to close. The relation is:

$$D = \begin{cases} T_B : 0 \leq S < T_A - T_B \\ (S - T_A + T_B) T_D T_C + T_B : T_A - T_B \leq S < T_A + T_C - T_B \\ T_B + T_D : T_A + T_C \leq S \end{cases}$$

The time response to a command to close in terms of retarder position (observed) and deceleration force on a car (inferred) is qualitatively as depicted in FIG. 3.

Obviously the actual dynamics of the retarder are more complicated than this model indicates. However, for the purpose of car control the response times are the important consideration, not the details of retarder movement. These times were validate by comparing results obtained using the model in simulation with actual observations made on a group retarder at the classification yard of the Southern Pacific Transportation Co. in Eugene, Oregon. Observations were made of the position-time profile for the retarder under various conditions. The parameters T_A through T_E were determined using these observations.

For the three line pressures used to pressurize the retarder cylinder (corresponding to three weight classes of cars), the parameters values obtained from the field measurements are shown in Table I. It should be noted that these values are subject to change with changes in line pressures, retarder age and adjustment, and retarder model. The value of T_E was inferred to be approximately 0.25 second.

Table I

Retarder Parameters

	T_A	T_B	T_C	T_D Seconds
Low Pressure	0.50	0.15	1.7	1.0
Medium Pressure	0.50	0.20	1.7	1.1
High Pressure	1.10	0.20	1.7	0.5

As might be expected, the sluggish response of the retarder determines the coarseness of resolution by which small amounts of energy can be removed from the car. More specifically, since force is linearly proportional to deceleration, for a car in the retarder, the area under a force-time curve is proportional to velocity. Hence controlling the retarder to have a certain force-time profile is equivalent to removing an increment of velocity proportional to the area beneath the profile. The assumptions and observations of response to the two commands, taken together, imply that there is a smallest amount of velocity which can be removed from a car. In other words, the retarder takes a "bite" of velocity out of the car, and there is a minimum size to this bite. This amount of velocity is

$$\Delta V_{min} = (Fg/2W)\,(T_A - T_E)$$

where W is car weight, F is maximum decelerating force, and g is the acceleration of gravity. This situation corresponds to the profile of FIG. 4. A similar calculation shows that the amount of velocity removed from a car from the time of command to open to the actual opening time is

$$\Delta V = (Fg/2W)\,(T_A - T_E) + (Fg/W)\,T_E$$
$$= Fg/2W\,(T_A + T_E)$$

if the retarder is fully closed at the time of command to open.

A control algorithm which gives a reasonably constant deceleration profile as well as achieving the required exit velocity must take into account the fact that commands to the retarder control mechanism are limited to two; i.e. open and close. Consequently, it is noJ possible to select a desired deceleration except in an average sense as a succession of applications and releases of the retarder. The result of such a policy is depicted in FIG. 5. In this figure the deceleration profile is plotted in a velocity-squared (V^2) versus distance-along-the-retarder (X) space. This is done for two reasons: First, the distance a car has moved through the retarder is more meaningful than the time that is has been in the retarder, since deceleration must be accomplished within the length of the retarder, rather than in a specified time. Second, in a V^2 vs. X space the curve of constant deceleration is a straight line, and thus it is conceptually easier to evaluate the smoothness of a particular profile.

In order to give the retarder the proper commands to decelerate the car down the deceleration line in the manner of FIG. 5, an algorithm was developed using the deceleration line as a switching line, and using a simple predictor to compensate for the significant and unequal delays in response to commands to the retarder. The algorithm works as follows: Initially the retarder is closed. After the car has entered, at intervals of one-fourth second, the velocity and position are computed from actual speed measurements to determine whether the car is above or below the line in $V^2 - X$ space. The car position and velocity are predicted ahead by an amount of time depending on the car's initial location relative to the switching line. If the predicted location lies above the line the retarder is commanded to close; otherwise the command is to open.

Because of the retarder response, however, excursions from the switching line are considerable, and good exit speed accuracy cannot be guaranteed. To meet the terminal requirement, the second part of the algorithm was developed. This part monitors car velocity and maximum deceleration, and when the car velocity approaches V_{FINAL} it initiates the terminal phase of control. It is necessary to anticipate reaching V_{FINAL} by a considerable amount, because the retarder may be in closed position and will then open only after a delay, causing the car to decelerate below the desired value. The amount of velocity Δ by which V_{FINAL} must be anticipated depends on the state of the retarder (and several other parameters), and not merely on whether it is on or off. To include this dependence in the algorithm would add significant complexity. Therefore, an alternative approach is used. In this approach, the retarder is driven into a known state (fully closed) and then commanded off when the velocity reaches $V_{FINAL} + \Delta$, where Δ is now only a function of T_E and T_A and of the maximum deceleration. Thus the terminal velocity is reached with the retarder open — a necessary condition. Actually Δ depends on X and on rollability, but this dependence is suppressed in the algorithm for simplicity, with only a small loss of terminal accuracy.

The terminal phase of control is started at the last computation time for which

$$V - V_{FINAL} \geq A_{MAX}(T_A + T_E)$$

where A_{MAX} is the maximum deceleration (measured as the car enters the closed retarder). When the inequality above is satisfied, the retarder is commanded on; peak deceleration is measured again in case it differs from A_{MAX}, and the new peak deceleration, A, is used to evaluate the inequality

$$V - V_{FINAL} \leq ½ A (T_A + T_E).$$

At the first computation time for which this inequality is satisfied, the retarder is commanded to open. Should the velocity V subsequently increase to the point where $V - V_{FINAL} > ½ A_{MAX} (T_A + T_E)$, the terminal control operation is repeated.

A flow chart of the algorithm is shown in FIGS. **6** and **7**. The symbols used in the flow chart are shown in Table II.

TABLE II

Symbols used in Flow Chart shown in FIGS. **6** and **7**

K	Parameter depending on the retarder characteristics
UP	Amount of prediction when the retarder is off
DOWN	Amount of prediction when the retarder is on
C	Parameter that determines initialization of terminal phase
IDELT	Inverse of the control interval
L	Length of effctive retarder control
Phase	Phase of operation
AMAX	Maximum acceleration
X	Position
W	Weight category
VINITIAL	Initial velocity
VFINAL	Final velocity
VVINITIAL	Initial velocity squared
VVFINAL	Final velocity squared
V	Velocity
U	Control
VPAST	Past velocity
A	Acceleration
VV	Velocity squared
PV	Predicted velocity
PX	Predicted position
PVV	Predicted velocity squared

The algorithm is programmed on the digital computer **20** and, as previously explained, signal input from the radar unit **18** is processed in the computer according to the algorithm to determine the sequence of command signals to be issued from the computer to the associated retarder mechanism.

It will be understood that the above description of the present invention is susceptible to various modifications, changes and adaptations, and the same are intended to be comprehended within the meaning and range of equivalents of the appended claims.

We claim:

1. In a system for controlling the speed of a railroad car rolling, under the influence of gravity, down an inclined track and onto one of a plurality of destination tracks, the combination which comprises:

a. a car retarder located along the rails of the inclined track and selctively operable between a braking position wherein the car wheels are engaged as the car progresses through the retarder toward an exit end thereof, and a non-braking position;

b. a retarder control mechanism responsive to electrical signals and connected for actuating said retarder to move it between braking and non-braking positions;

c. a first means positioned uphill of said retarder, said means producing electrical output signals indicative of the car speed as it approaches said retarder;

d. a second means positioned adjacent said retarder and producing a plurality of separate electrical output signals each indicative of the car speed at a respective one of a plurality of positions of the car within said retarder;

e. a weight responsive means positioned in the inclined track uphill from said retarder to produce electrical output signals indicative of the weight of the car approaching said retarder;

f. track circuit means associated with each of the plurality of destination tracks to produce electrical output signals indicative of railroad car occupancy on each of the destination tracks; and

g. a digital computer connected to receive, as electrical input signals, the electrical output signals of said first means, said second means, said weight responsive means, and said track circuit means, said computer being programmed to constitute a means for

i. receiving said input signals from said first means, said weight responsive means and said track circuit means to compute an exit speed which the car should have as it leaves the exit end of said retarder so as to cause a car to arrive at the one of the distination tracks with a desired speed,

ii. utilizing the series of separate electrical output signals from said second means to compute from each input signal the car speed and location of the car within said retarder at the time each speed measurement is taken,

iii. computing a projected speed and location for the car as of a later time after each such time of measurement, the interval of time between the time of actual speed measurement and the later time being determined in the computer in dependence on parameters established by the dynamics of said car retarder,

iv. comparing the computed projected values with further computed values, for such later time, which further computed values are those required to achieve a uniform rate of deceleration of the car through the effective length of said retarder, said uniform rate of deceleration of said car being computed from the measured speed of the car as it enters said retarder and the computed exit speed, and

v. transmitting electrical signals to said retarder control mechanism to move said retarder to its braking position, or to its non-braking position, in dependence on whether the computed projected speed is above or below, respectively, that of the computed speed which is required, at the projected location, to achieve the desired uniform deceleration rate for the car.

2. In a system as defined in claim 1, wherein said computer is further programmed to constitute a means for initiating a terminal phase of control of said retarder as the car speed in said retarder approaches the computed exit speed so as to insure that said retarder is in a non-braking position when this computed exit speed is reached.

3. In a system as defined in claim 2, wherein said terminal phase of control is initiated at a time when the car has passPd through substantially the entire length of said retarder.

4. In a system as defined in claim 2, wherein during the terminal phase said computer issues a first electrical signal to said retarder control mechanism to first move said retarder to braking position at a time when the speed of the car is higher than the computed exit speed and then issues a second electrical signal to move said retarder to non-braking position, the second electrical signal being given with a time lead established in dependence on said parameters of said retarder so that said retarder is in a non-braking position when the car reaches the computed exit speed.

5. In a system as defined in claim 1, wherein said first and second means are radar-units.

6. In a system as defined in claim 1, wherein the combination further comprises pulse shaping and priority interrupt circuits between said computer and said first and said second means for transmitting the electrical output signals from said means to said computer.

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