United States Patent

[11] 3,581,071

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[21] Appl. No. 815,075
[22] Filed Apr. 10, 1969
[45] Patented May 25, 1971
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[54] **TRAIN LENGTH MEASURING DEVICE**
14 Claims, 4 Drawing Figs.

[52] U.S. Cl. 235/151.32, 246/122, 340/47
[51] Int. Cl. G01b 7/04
[50] Field of Search 235/151.32; 246/182, 1; 340/31, 38

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ABSTRACT: An apparatus and method for measuring the overall length of a series of connected and moving articles each of which may be of indeterminate length. The example to be described comprises interconnected railroad cars forming a train. The total length of the train is determined by employing two separated photocells and two light sources, each source normally shining on a respective photocell, so that each car of the moving train sequentially breaks the lightbeams to the photocells causing the photocells to produce electrical outputs. Since the distance between the two photocells is known and the time which each car takes to travel from one to the other is easily determined from the occurrences of output signals from the photocells, the distance from the beginning of one car to the beginning of the next is computed, the computations being accumulated to indicate the total train length.

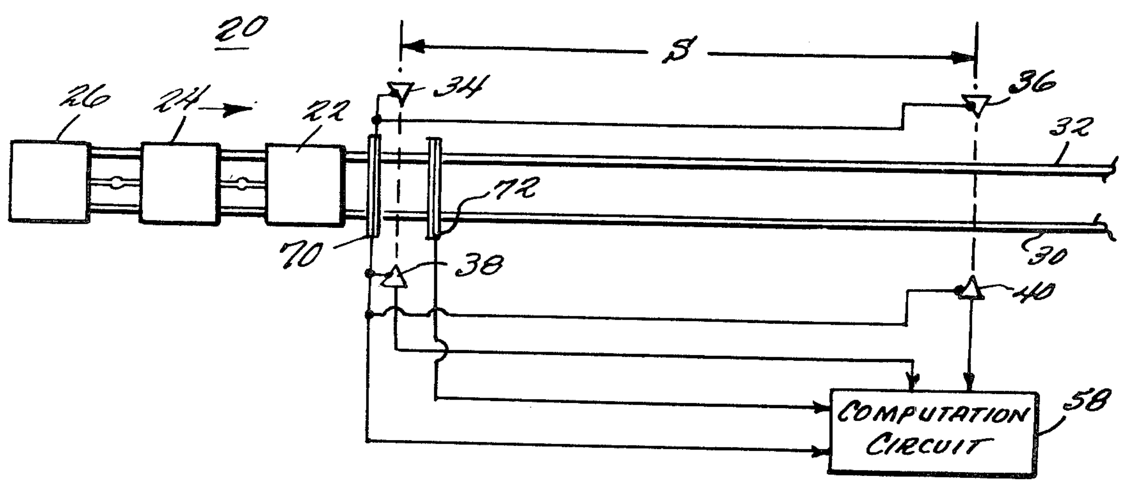
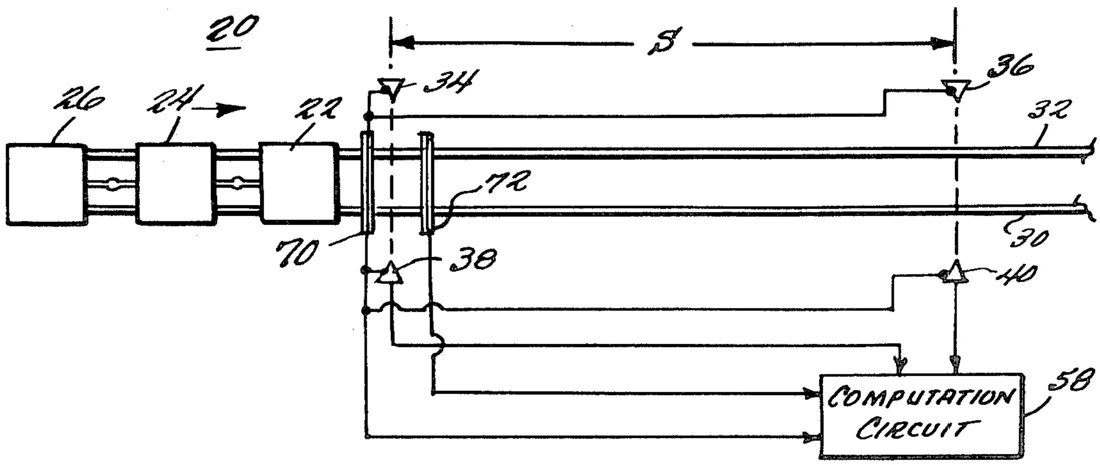


Fig. 1



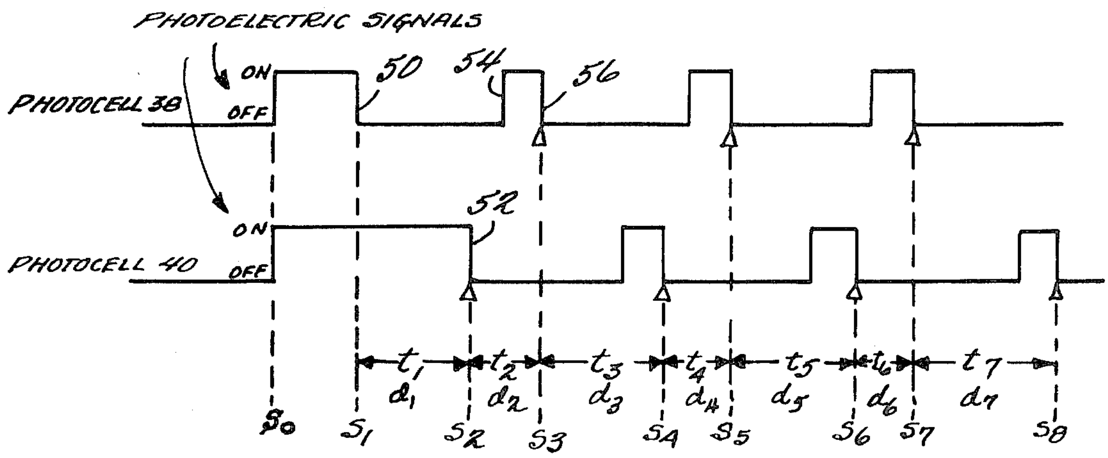


Fig. 4

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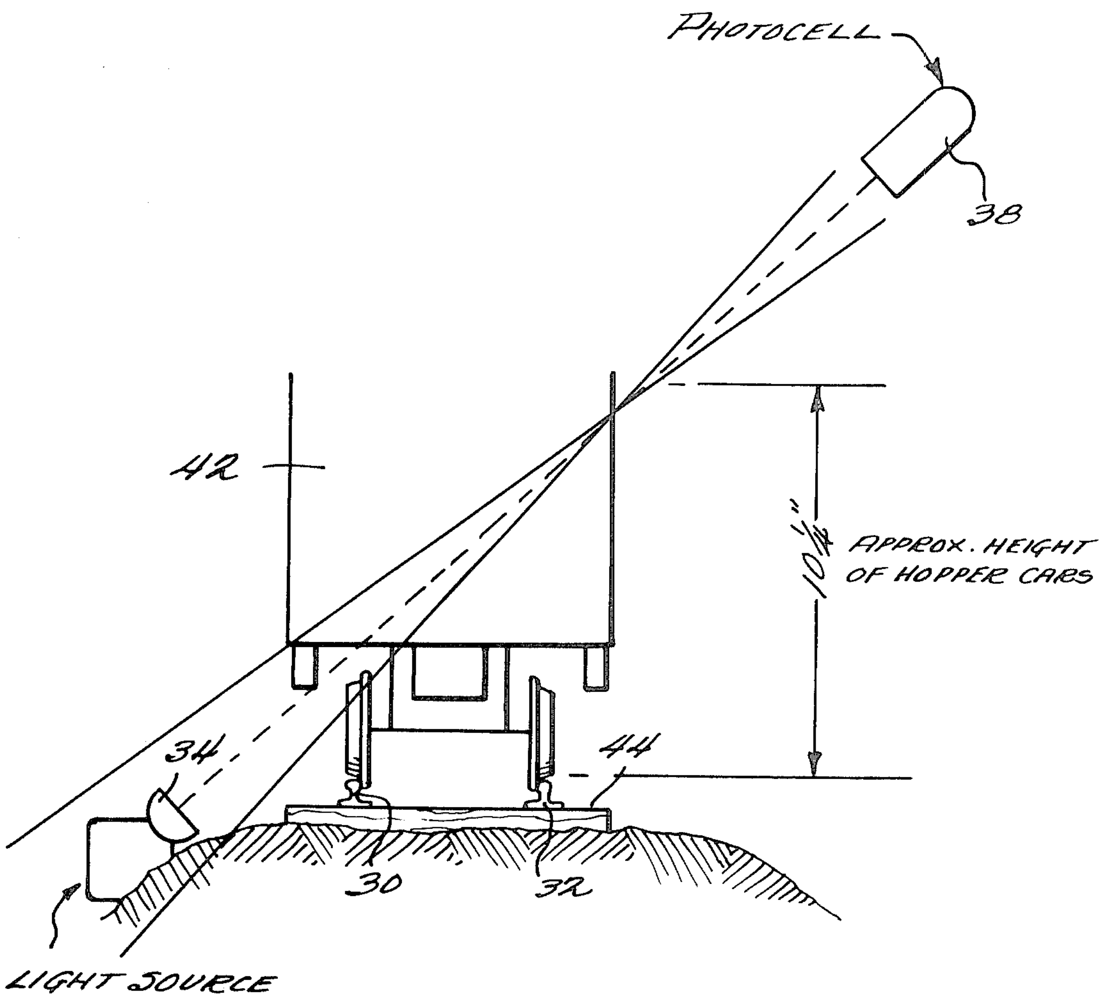

Fig. 2

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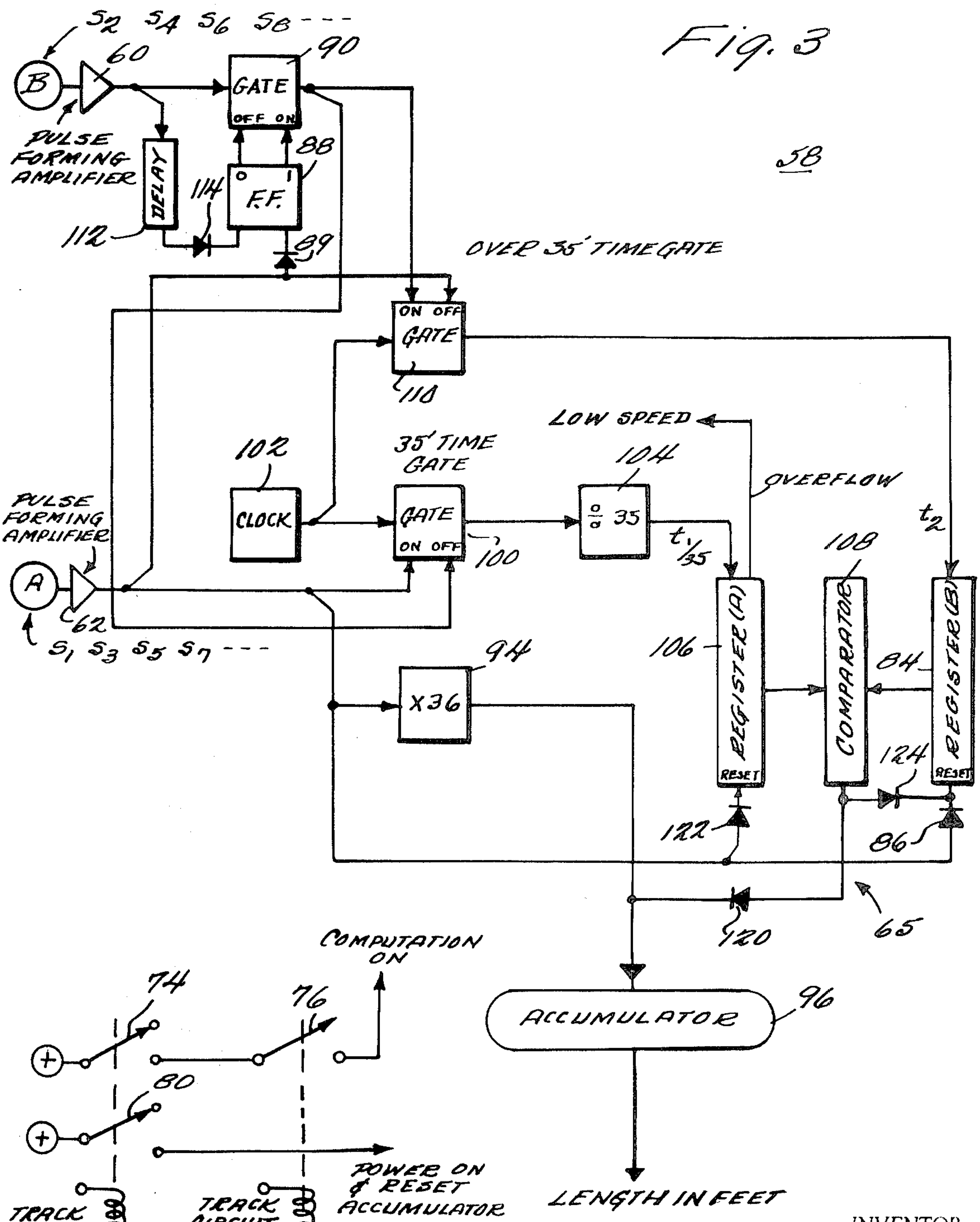
Fig. 3



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TRAIN LENGTH MEASURING DEVICE

BRIEF DESCRIPTION OF THE PRIOR ART AND SUMMARY OF THE INVENTION

The invention relates to an apparatus and method for measuring the overall length of a chain of moving articles, each of indeterminate length, such as the cars forming a railroad train.

It is often desirable to know the overall length of a long chain of moving articles each of which may have a different and unknown length, and the need for detecting the overall lengths of railroad trains is particularly acute. Besides providing general records which are of great value and interest, such train length determinations are particularly desirable at locations where a train may be routed to one or another siding since it is vital to know in advance whether the train, which, of course, may stretch for more than a mile or two, will fit within a particular siding.

Many attempts have been made in the prior art to measure the overall lengths of railroad trains, but all have proved either too complex, expensive, or unreliable to be practical or too inaccurate in their computations to be worthwhile. Although, it is simple enough to measure the time between when the train reaches a given point and when it leaves that or another point, it is much more difficult to continually determine the velocity and acceleration of the train as it passes the measuring point or points especially when dealing with accelerating or decelerating trains of extraordinarily long lengths. Without measuring velocity and acceleration continuously, or without somehow minimizing the errors resulting from changes in velocity and acceleration, it is virtually impossible to accurately measure the length of a train the velocity and acceleration of which are changing.

The present invention accomplishes such a measurement accurately by individually determining the distances between the fronts, or leading edges, of adjacent railroad cars which pass successively by two separated sensing devices, each comprising a light source and photocell, and then summing all of the front-to-front distances so measured to determine the total length of the entire train. By making such a car-by-car determination, the errors due to acceleration and changes in acceleration are minimized and, as will be seen hereinafter, for all practical purposes are eliminated.

The invention includes an arrangement of two separated sensing devices mounted along a railroad track and a simple computing device connected to the devices which can quickly and accurately compute the train length and which does not require data to be stored during computation. The arrangement can be adapted for use regardless of the direction of travel of the train, and accurate measurement over a wide range of speeds is possible. Furthermore, accuracy is not reduced by variations in car lengths or dimensions. Accordingly, the detection device of this invention is quite simple and reliable while at the same time economical to install and maintain.

In the embodiment set forth below, each of the two sensing devices comprises a photocell and a light source mounted across the railroad track from the photocell so as to project a lightbeam across the track onto the photocell, and the two sensing devices are separated by a distance which is less than the length of most cars. As the moving train passes the first sensing device and blocks the light beam which is directed towards the first photocell, an electrical signal is produced causing the computing network to begin calculating the length of the first car of the train. The interruption of the beam to the first photocell, and the electrical signal resulting therefrom, produces a pulse in the computing network which is applied to logic circuitry to control the gating of clock pulses through a divider to a first register where the received pulses are counted. When the moving train breaks the beam from the second light source, which has been striking the second photocell, another electrical pulse is produced and this pulse causes the logical network to shift the same free-running clock pulses directly to a second register where the pulses are counted. The two registers in effect record time. When another electrical signal at the first photocell is produced indicating that the moving car being measured has completely passed the first sensing device and the next car has broken the beam, the clock pulses are shifted back to the divider. During the period when clock pulses are applied to the second register, the contents of this register are compared with those of the first register. When the pulse counts are equal, a pulse is generated to reset the second register and to be applied to an accumulator in which is already stored a number representing roughly the separation between the sensing devices, this number having been entered at the time that the first pulse was produced. As will become apparent from the discussion below, the total information added to the accumulator for each car represents the distance from the front of one car to the front of the next. This calculation is then repeated for each car until the entire train has passed at which time the total count in the accumulator is roughly equal to the overall train length.

Details of the invention will become clear from reading the following description of an illustrative embodiment of the invention.

A BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram illustrating a train approaching the sensing devices;

FIG. 2 is a diagrammatic view of the position of a light source and a photocell with respect to a railway car being sensed;

FIG. 3 is a block diagram of a logical and computation circuit for determining the distance from the beginning of a car to the beginning of the next car and for accumulating all of such distances to determine the overall train length; and

FIG. 4 is a graphical representation of photocell outputs versus time.

DETAILED DESCRIPTION OF THE INVENTION

Reference is now made to FIG. 1 which diagrammatically illustrates this invention as used in measuring a conventional train **20**, which is shown as comprising three cars **22**, **24** and **26**, approaching the measuring arrangement on a pair of conventional rails **30** and **32**. Of course, most railroad trains are of much greater length than three cars and, in fact, can stretch a mile or more. It is with these extremely long trains that this invention is particularly useful.

As shown in FIG. 1, two sources of light **34** and **36** are disposed so as to normally direct light onto conventional photocells **38** and **40**, respectively, which are both connected to computation circuitry **58**. One arrangement of the light source **34** and photocell **38** is shown in greater detail in FIG. 2, wherein the lightbeam is shown just about to be interrupted by the leading edge of a moving car **42**. In FIG. 2, the light source **34** is disposed at roughly the level of the railroad crossties **44**, while the photocell **38** is disposed on the opposite side of the rails **30** and **32** from source **34** and preferably at an elevation of 10 to 15 feet above the ground. Thus, the lightbeam from source **34** is projected upwardly at a substantial angle. Interruption of the beam by a railroad car causes the photocell **38** to produce an electrical signal as will be further described hereinafter.

When the first car **22** of the train **20**, which would ordinarily be the engine pulling the other cars, breaks the beam projected by the light source **34** onto the photocell **38**, the photocell **38** responds by changing its electrical output from one condition, arbitrarily called "on," to another condition, arbitrarily called "off." This is shown in FIG. 4 in which the change in output, indicated as **50**, occurs at the point in time S_1 at which the beam from the light source **34** is interrupted. The train **20** moves onward and at time S_2 car **22** interrupts the beam from the source **36** causing a change in output, shown as **52** in FIG. 4, from the photocell **40**. As discussed in detail below, the separation between the photocells **38** and **40**, which is labeled S in FIG. **1**, is preferably sufficient to minimize errors due to acceleration and yet less than the length of most of the cars in the train, so that each car interrupts the beam from source **36** before the following car breaks the beam from source **34**.

After car **22** has passed the beam from source **34**, the output of photocell **38** returns to its previous condition, as shown by **54** in FIG. 4. Since it is desired to determine the total length of the train **20** rather than the length of any individual car, the change is output **56** produced at times S_3 when car **24** breaks the beam to the photocell **38** is employed to signify the end of the distance measuring period rather than the pulse **54**. Thus, the distance between the fronts of adjacent cars is calculated rather than the length of an individual car.

As shown in the graphs of FIG. 4, each moving car covers a distance d_1 in a time t_1 between the output changes **50** at time S_1 and **52** at times S_2 representing, respectively, the time that a car breaks the beam from the source **34** and the time at which it interrupts the beam from source **36**. Since the distance d_1 is obviously the distance which separates the two sources **34** and **36**, and the time t_1 can be easily determined using appropriate electrical circuitry responsive to changes **50** and **52**, the average velocity v_1 at which the car being measured is moving during this time t_1 can be computed by dividing d_1 by t_1. If it is assumed that the car continues to move at this same velocity (the accuracy of this assumption is discussed below), then the distance d_2 which the car moves during time t_2 (which is the time from which the car first interrupts the beam to the photocell **40** to the time at which the next car in line breaks the beam to the photocell **38**), can be calculated by multiplying the velocity v_1 times the second time interval t_2 which is determined by circuitry responsive to changes **52** and **56**. Thus, the total distance between the front of one moving car and the front of the next moving car can be established by summing the distance between the two photocells **38** and **40**, d_1, and the distance d_2.

The formulas for calculation are derived as follows:

$d_1=v_1t$

$d_2=v_2t$

and v_1 roughly equals v_2,

therefore, $d_1/t_1=d_2/t_2$;

and since $d_1=S$, $d_2=St_2/t_1$.

Assuming the distance S between photocells **38** and **40** is 35 feet, the total distance D between the leading edges of adjacent cars is as follows:

$D=d_1+d_2=S+S\ t_2/t_1$

or $D=35a0z35\ t_2/t$

Thus, it can be seen that the distance D is the sum of a constant and a variable, only the variable being subject to errors caused by acceleration or deceleration of the train.

Reference is now made to FIG. **3** which shows an arrangement of logical and other elements for performing the computations required to calculate the total distance D from the front of a car to the front of the next car and then to accumulate the distances so calculated in an output register which can be simply read without further computation or effort after the train **20** has passed to give the overall train length. As shown in FIG. 3, a pulse forming amplifier **60** senses the changes in electrical output from the photocell **40** signaling the detection of the front of cars which, as shown in the graph of FIG. 4, occur at times S_2, S_4, S_6, etc. The pulse forming circuit **62** similarly senses the changes in electrical output from the photocell **38** also signaling the detection of the front of cars, and as shown in FIG. 4, these changes occur at times S_1, S_3, S_5, S_7, etc. The pulse forming amplifiers **60** and **62** are intended to be of conventional type and any appropriate devices which will perform in the manner set forth below may be employed.

As shown in FIG. **1**, two conventional detecting circuits **70** and **72** are associated with the rails **30** and **32** in the immediate vicinity of the light source **34** and serve to produce appropriate signals when the presence of the train wheels passing them is sensed. The detecting circuit **70**, which is connected to sources **34** and **36** and photocells **38** and **40**, is disposed ahead of, and insulated from, the circuit **72** so that it detects the moving train **20** first, and the detection signal produced by circuit **70** serves to apply power to the photocells **38** and **40**, the sources **34** and **36**, and the computation circuit **58**, as well as resetting the accumulator **96** to zero. As shown in FIG. 3, both circuits **70** and **72** are required to be producing signals indicating the presence of a train before the computing circuit **58** can actually calculate. More particularly, in FIG. 3 the detection of a car by circuit **70** is represented as closing switches **74** and **80** while the closing of switch **76** is shown resulting from the detection of a car by circuit **72**. The closing of switch **80** applies power to the circuitry **58**, the photocells **38** and **40**, and sources **34** and **36** and resets the accumulator **96** to zero. The subsequent closing of switch **76** readies the circuit **58** for computation. Thus, the system cannot be inadvertently actuated, for example by a person walking down the tracks.

After power supply and resetting has occurred due to detection of a car by circuit **70**, the first signal received by the arrangement shown in FIG. 3 will, of course, be a change in electrical output **50** from photocell **38** at the time S_1, and this change is converted by the amplifier **62** to an appropriate pulse for causing the registers **84** and **106** to be reset via the diodes **86** and **122**, respectively.

The output of amplifier **62** is also applied to the flip-flop **88** via diode **89** to cause flip-flop **88** to shift from its "off" or zero to its "on" or one condition, thereby enabling the gate **90** in preparation for a signal from the pulse forming amplifier **60** in response to the subsequent interruption of the beam to the photocell **40**.

Also, the pulse from the amplifier **62** is multiplied by 36 in the appropriate circuitry **94**, for the reasons set forth below, and the output from **94**, which may be in the form of 36 short pulses, is applied to the accumulator **96**.

The detection of the first car by circuit **72** permits computation of distance to proceed as will now be described.

The pulse produced by the amplifier **62** is applied to a logic gate **100** thereby enabling gate **100** to pass a train of uniformly spaced timing pulses from a free-running, pulse-producing clock **102** to a circuit **104** which divides the number of pulses received by 35, so that one pulse is produced at the output of circuit **104** for each 35 pulses received on its input. The pulses from circuit **104** are then counted in a register **106**, the output of which is applied to a comparator circuit **108** as described below.

The output of the amplifier **62** is also applied to the "off" input of the logic gate **110** to prevent signals from passing from the clock **102** through the gate **110** to accumulate a count in the register **84**, which, as discussed hereinafter, is used in determining the time t_2 as shown in the graph in FIG. **4**.

A short time after the change in signal **50** produced at time S_1 occurs, another change **52** is sensed at the input of pulse amplifier **60** at time S_2 as the car being measured interrupts the beam produced by the source **36** and striking photocell **40**. The pulse output of amplifier **60** is then applied to the gate **90**, and since gate **90** was previously enabled by the output of the amplifier **62** at time S_1, the pulse passes gate **90** and is applied to the gate **110** to enable gate **110** thereby passing the output of clock **102** directly to register **84** which counts the clock pulses.

The output of the gate **90** is also applied to the "off" input of the gate **100** to disable the gate and to prevent further pulses from being applied to the register **106** by the clock **102**. The output of the pulse forming amplifier **60** is also applied through a delay circuit **112** and a diode **114** to the flip-flop **88** to turn that flip-flop off and disable the gate **90** until another pulse from the amplifier **62** is received at time S_3 by flip-flop **88** to again enable the gate **90**.

As the counts are stored in register **84**, a comparison is made with the counts in register **106** by the comparator **108**.

When the counts in register **84** and **106** are equal, a pulse is generated by the comparator **108** and is applied to the accumulator **96** via diode **120**. Also, the pulse from the comparator **108** is applied via diode **124** to register **84**, resetting this register to a zero count. This sequence continues until a signal change is sensed at time S by pulse forming amplifier **62** to disable the gate **110** and prevent further pulses from being applied to the register **84**. During the comparison period, the comparator **108** actually performs the division of t_2 by $t_1/35$.

As pointed out above, the total distance from the beginning of one car to the beginning of the next is equal to the distance between the two sources, 35 feet in this embodiment, plus that distance times the ratio of t_2 to t_1. This sum is calculated in the illustrative embodiment, in the manner just explained, by first adding 36 to the accumulator via multiplier **94**. The number 36 is used to compensate for errors resulting from roundoffs in the division. Then added to the accumulator is the comparator output, 35 times the time t_2 divided by the time t_1.

Thus, as each individual car passes the photocells **38** and **40** in turn, the distances from the front of each car to the front of the next are calculated and successively added to the accumulator **96**. The last car of the train is sensed by photocell **38** to cause a count of 36 to be entered into the accumulator **96**. However, before any further input to the accumulator can be generated by the computation circuit **58**, circuit **70** opens to terminate the computation. At this time the accumulator holds a count representative of the total length of the train.

Since a minimum car length equal to the distance between the separated photocells **38** and **40** is assumed, and the acceleration and changes in acceleration of the train during the computing periods are ignored, the system discussed above is inherently subject to a certain amount of error. This error is obviously largest when the train is moving at a minimum speed and, for the embodiment shown in FIG. **1** with a separation between photocells of 35 feet, the minimum speed with which any accurate measurement can be made has been found to be approximately 4½ to 5 miles per hour. Below this speed the measurement has been found to be grossly in error. Thus, it is desirable to detect low train speed below a given minimum and to eliminate any distance information which results from measurement at or below such speed. This slow speed detection is accomplished in the embodiment shown in FIG. **3** by detecting an overflow of the register **106**. This overflow is designed to occur when the number of pulses received in register **106** exceeds a chosen number. The overflow causes the computation to stop and the accumulator **96** to be reset to zero. The circuit **58** then remains in this suspended condition until the train **20** being measured clears the circuits **70** and **72** at which time the circuit **58** is once again made ready to respond to the next train and calculate its speed.

On the other hand, excessive error in the train length calculation may result if the train speed is so great as to cause the circuitry to operate near its upper frequency limits. However, the proper choice of conventional electronic components in a manner which is well known will permit the maximum allowable train speed to be well in excess of 60 miles an hour without resulting in substantial loss of accuracy.

As pointed out above, the measurement system of FIG. **1** makes no allowance for acceleration of the car after the average velocity has been determined during the first 35 feet of travel. This assumption obviously introduces errors into the calculated car length if the train **20** is accelerating or decelerating, but these errors have been found to be small and acceptable. The longest car entering the track at minimum speed and maximum acceleration will obviously produce the greatest error and for an acceleration of 1 foot per second per second, which is the maximum expected, a car length of 94 feet, an initial speed of 4.1 mile per hour and an overall train length of 7,144 feet in 76 cars, the errors due to acceleration for each of the cars have been found to be roughly as follows:

Car No.	True length (in feet)	Computer length (in feet)	Difference (in feet)
1	94	73.31	−20.69
2	94	85.61	−8.39
3	94	88.66	−5.34
4	94	90.09	−3.91
5	94	90.90	−3.10
6	94	91.46	−2.54
7	94	91.82	−2.18
8	94	92.09	−1.91
9	94	92.31	−1.69
10	94	92.48	−1.52
11	94	92.64	−1.36
12	94	92.74	−1.26
13 thru 76	Ea. 94	Ea. 93.00	[1] −64.00
Total	7,144	7,026.11	−117.89

[1] Total 13 thru 76.

It is thus apparent that the error at this low speed for the first few cars is substantial, but as the speed increases the errors decrease until, for the last 63 cars, they amount to roughly only a foot per car. The total difference between the true overall train length and the calculated length as shown is only 118 feet and this amounts to an error of only about 1.65 percent. Thus, it can normally be assumed that, for any train, the acceleration error will be less than 120 feet and results can be examined on that basis.

To determine the acceleration error for an average train it is assumed that an acceleration of 0.4 feet per second per second is an average value and a car length of 60 feet and a speed of 20.5 miles per hour are typical. Thus, with a train length of 9,000 feet and 150 cars the errors due to acceleration are as follows:

Car No.	True length (in feet)	Computer length (in feet)	Difference (in feet)
1	60	59.678	−0.322
2	60	59.694	−0.306
3	60	59.708	−9.292
4	60	59.719	−0.281
5	60	59.736	−0.264
6	60	59.741	−0.259
7	60	59.754	−0.246
8	60	59.765	−0.235
9	60	59.770	−0.230
10	60	59.780	−0.220
11 thru 150	Ea. 60	Ea. 59.800	[1] −27.800
Total	9,000	8,969.545	−30.455

[1] Total 11 thru 150.

An average train with these characteristics would have therefore an error of only about 31 feet out of almost 9,000 due to acceleration. This is only 0.34 percent of the total train length and is small enough to be almost negligible. Of course, in the above examples the acceleration was assumed to be positive, that is the train speed was increasing, but if deceleration is occurring, the error would be approximately the same size but of opposite direction.

If by chance a car having an overall length less than the distance between the photocells is encountered, the car is computed as having a length equal to said distance. This introduces a positive error in the computation. To overcome such error, the distance between photocells should not be longer than the shortest car measured.

Another source error is introduced by the clock pulses produced by the clock **102** shown in FIG. **3** since the output can vary by as much as one pulse for any given time interval. This error can be minimized by running the clock at a frequency of 10,000 cycles per second, thus making the maximum error practically zero.

Another error results from the division operation within the circuit **104** since it is contemplated that the fractional remainder of the quotient will be discarded. However, with a train speed of 4.1 miles per hour, it has been shown that this discarding of remainder results in an error of less than 0.06 percent of the residual car length over 35 feet (no error in the first 35 feet of the car length) and even when the car is travelling at 60 miles per hour, the error is still only 0.88 percent of the residual car length in excess of the first 35 feet. Similarly, the second division of t_2 by t_1 also omits the remainder and thus also produces a slight error. However, this error is compensated for by increasing the constant value 35 which is fed into the accumulator **96** to 36, and this on the average adds one-half foot to the calculated length of the car

Yet another source of error results from the fact that the separation between the photocells **38** and **40** is chosen to be 35 feet in this embodiment and any car with an overall length less than 35 feet is computed as having a length of 35 feet. However, the acceleration error is decreased as the length of the separation between the photocells **38** and **40** approaches the length of the cars being measured. Thus, to minimize acceleration errors the photocell separation should be equal to the length the car being measured, while to minimize errors resulting from short cars, the length between the photocells needs to be no longer than the shortest car. A separation of 35 feet has been selected as a value which substantially satisfies both of these mutually antagonistic conditions since freight cars having coupler length less than 35 feet are rare and the acceleration error of the system using a 35 feet separation is well within acceptable limits.

Yet another small error is introduced by the train overhang beyond the last pair of wheels which adds roughly 10 feet to the calculation. The time delay of the electrical and mechanical sensing devices and the errors resulting therefrom will be ordinarily negligible. For the train in what is thought to be among the worst possible situations, consisting of 76 cars of 94 feet in overall length, the following tabulation gives all the errors expected:

[In feet]

Train length	Acceleration error	End of train error	Short car error	Computing error	
				Division	Rounding
7,144	−118	+10	0	+21	+38

The computed train length is then 7,095 feet for total error of less than −49 feet. However, to insure that a train will always fit into a sliding, it is preferable that any error should always be positive and that calculated train length should never be less than the true length. This can be accomplished by adding a fixed amount to each computed train length. For realistic situations, the total error, however, will probably be positive and accordingly it will be unnecessary to add a positive safety factor to the total calculated train length.

For the train in the average case consisting of 150 cars of 60 feet overall length, the following tabulation gives all the expected errors. Computed train length in this example would be 9,080 feet for a total error of only plus 80 feet or approximately one car length.

[In feet]

Train length	Acceleration error	End of train error	Short car error	Computing error	
				Division	Rounding
9,000	−30	10	4	21	75

The system as shown in FIG. **1** is designed for measuring the total train length when the direction of the train travel is from the light source **34** to the light source **36**. To measure train length for the reverse train direction, however, it is simple to provide means whereby train direction can be detected and circuits to the photocell detectors **38** and **40** reversed so that the photocell **40** is applied to amplifier **62** while the output of the photocell **38** is applied to the amplifier **60**. With additional circuits of the type **70** and **72** FIGS. **1** and **3**) positioned immediately adjacent light source **36**, these additional circuits being insulated from each other and from circuits **70** and **72** adjacent source **34**, precise measurement of train length can be obtained in the same manner as heretofore described. If less accuracy can be tolerated, only original circuits **70** and **72** may be utilized. However, this would require that circuit **72** have associated therewith a further contact connecting a source of power to photocells **38** and **40**, sources **34** and **36** and the computation circuit **58**, as well as resetting accumulator **96**. By using only original circuits **70** and **72** for both directions of train travel, an error approximating the separation of the photocells (in this case 35 feet) would occur when the train is moving from light source **36** to source **34**.

The measuring system of this invention is a particularly simple, accurate, economical and reliable device for determining the overall length of a series of moving connected articles, such as railroad cars. The above example of the invention is merely intended to set forth an illustrative embodiment and many changes and modifications are possible without departing from the spirit of the invention. Accordingly, the above invention is intended to be limited only by the scope of the appended claims.

What I claim is:

1. A method of determining the total length of a plurality of moving articles, said method comprising the steps of:
   - detecting the leading edge of an article as it passes a first sensing device to produce a first electrical signal,
   - detecting the leading edge of said article as it passes a second sensing device separated from said first device by a given distance to produce a second electrical signal,
   - determining a first time interval between the time when said first signal is produced and the time when said second signal is produced,
   - detecting the leading edge of the next article as it passes said first sensing device to produce a third electrical signal,
   - determining a second time interval between the time when said second signal is produced and the time when said third signal is produced,
   - utilizing said first and second time intervals and said given distance to calculate the distance from the leading edge of said one article to the leading edge of the next article, and
   - summing all of the distances from the leading edge of one article to the leading edge of the next article to determine the approximate total length of said plurality of moving articles.

2. A system for measuring the total length of a chain of moving articles, said system comprising:
   - first detecting means for detecting the leading edge of each said article and for producing a first signal at the time said edge is detected,
   - second detecting means separated from said first detecting means by a given distance for detecting the leading edge of each said article, after said edge is detected by said first detecting means, and for producing a second signal at the time said edge is so detected,
   - means operatively connected to said first and second detecting means for determining a first time interval between the time when said first signal is produced and the time when said second signal is produced for any given article,
   - means operatively connected to said first and second detecting means for determining a second time interval between the time when said second signal is produced for said given article and the time when said first signal is produced for the next succeeding article,
   - computing means operatively connected to said means for determining a first time interval and to said means for determining a second time interval, said computing means being adapted to utilize said first and second time intervals and said given distance to calculate the distance from the leading edge of one article to the leading edge of the next article, and
   - accumulator means for summing the distances from the leading edge of one article to the leading edge of the next article to determine the total length of said chain.

3. Apparatus as in claim **2** wherein each detecting means includes a photocell and a source of light positioned so that a beam of light is normally directed onto said photocell but is in-

terrupted by said article to cause the photocell to produce an output signal.

4. Apparatus as in claim 2, wherein

said means for determining a first time interval comprises means for producing a first number of pulses representing the time between the leading edge of one article being detected by said first detecting means and being detected by said second detecting means,

said means for determining a second time interval comprises means for producing a second number of pulses representing the time between the leading edge of said one article being detected by the second detecting means and the leading edge of the next article being detected by said first detecting means,

said computing means comprising means for developing a given pulse count representative of said given distance and means for effectively dividing said second number by said first number and for effectively multiplying the quotient by said given pulse count to result in an additional count representing the distance between leading article edges that is in excess of said given distance, and

said accumulator means comprises means for adding said given pulse counts and said additional counts for successive articles in said chain.

5. Apparatus for measuring the length of a moving railroad train made up of a plurality of connected cars comprising:

first means for detecting a given portion of each railroad car,

second means for detecting said portion of each railroad car after that car is detected by said first detecting means, said first and second means being separated by a given distance,

means for determining a first time interval between the detection of the given portion of one car by said first detecting means and by said second detecting means and for determining a second time interval between the detection of the given portion of said one car by the second detecting means and the given portion of the next car by said first detecting means,

means responsive to said given distance and said first and second time intervals for calculating the distance between the given portion of said one car and the given portion of the next car.

6. Apparatus as in claim 5, wherein said given portion is the leading edge of said car.

7. Apparatus as in claim 5, further including means for adding all of the distances between said given portions to produce a result approximating the total length of the train.

8. Apparatus as in claim 5, wherein said determining means includes:

a source of clock pulses,

a first register,

a second register,

means for routing said pulses to said first register during said first time interval so that said first register accumulates a number of pulses which is a function of said given distance and the duration of said first time interval,

means for routing said pulses to said second register during said second time interval so that said second register accumulates a number of pulses which is a function of the duration of said second time interval,

and means for comparing the numbers accumulated in first and second registers.

9. Apparatus as in claim 8, wherein said first detecting means produces an electrical pulse when the given portion of a car is detected to permit said routing means to route said clock pulses to said first register and said second detecting means produces an electrical pulse when said given portion is detected to route said clock pulses to said second register.

10. Apparatus as in claim 8, wherein said first register accumulates the total number of clock pulses produced during said first time interval by said clock pulse source divided by said given distance, said second register accumulates clock pulses produced during said second time interval, and said comparing means, during the second interval, divides the number accumulated in said second register by the number accumulated in said first register.

11. Apparatus as in claim 5, wherein said first and second detecting means each comprises a photocell and a source of light disposed in relation to said photocell such that said source produces a lightbeam which shines on said photocell except when interrupted by said cars.

12. Apparatus as in claim 5, including additional detecting means for sensing the presence of said train to actuate said first and second detecting means, said determining means, and said calculating means.

13. A method of determining the length of a moving railroad train made up of a plurality of cars comprising the steps of:

detecting the leading edge of a railroad car as it passes a first sensing device to produce a first electrical signal,

detecting the leading edge of said railroad car as it passes a second sensing device separated from said first device by a given distance to produce a second electrical signal,

determining a first time interval between the time when said first signal is produced and the time when said second signal is produced,

detecting the leading edge of the next railroad car as it passes said first sensing device to produce a third electrical signal,

determining a second time interval between the time when said second signal is produced and the time when said third signal is produced,

utilizing said first and second time intervals and said given distance to calculate the distance from the leading edge of said one car to the leading edge of the next car, and

summing all of the distances from the leading edge of one car to the leading edge of the next car to determine the approximate total length of said train.

14. A method as in claim 13, wherein said utilizing step includes the further steps of:

dividing said first time interval by said given distance,

dividing said second time interval by said divided first time interval, and

adding said second time interval divided by said divided first time interval to said given distance to produce the approximate distance from the leading edge of each car to the leading edge of the next.