

[54] **APPARATUS AND METHOD FOR
AUTOMATICALLY SERVICING
JOURNAL BOXES OF RAILROAD CARS**

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104/1; 246/246

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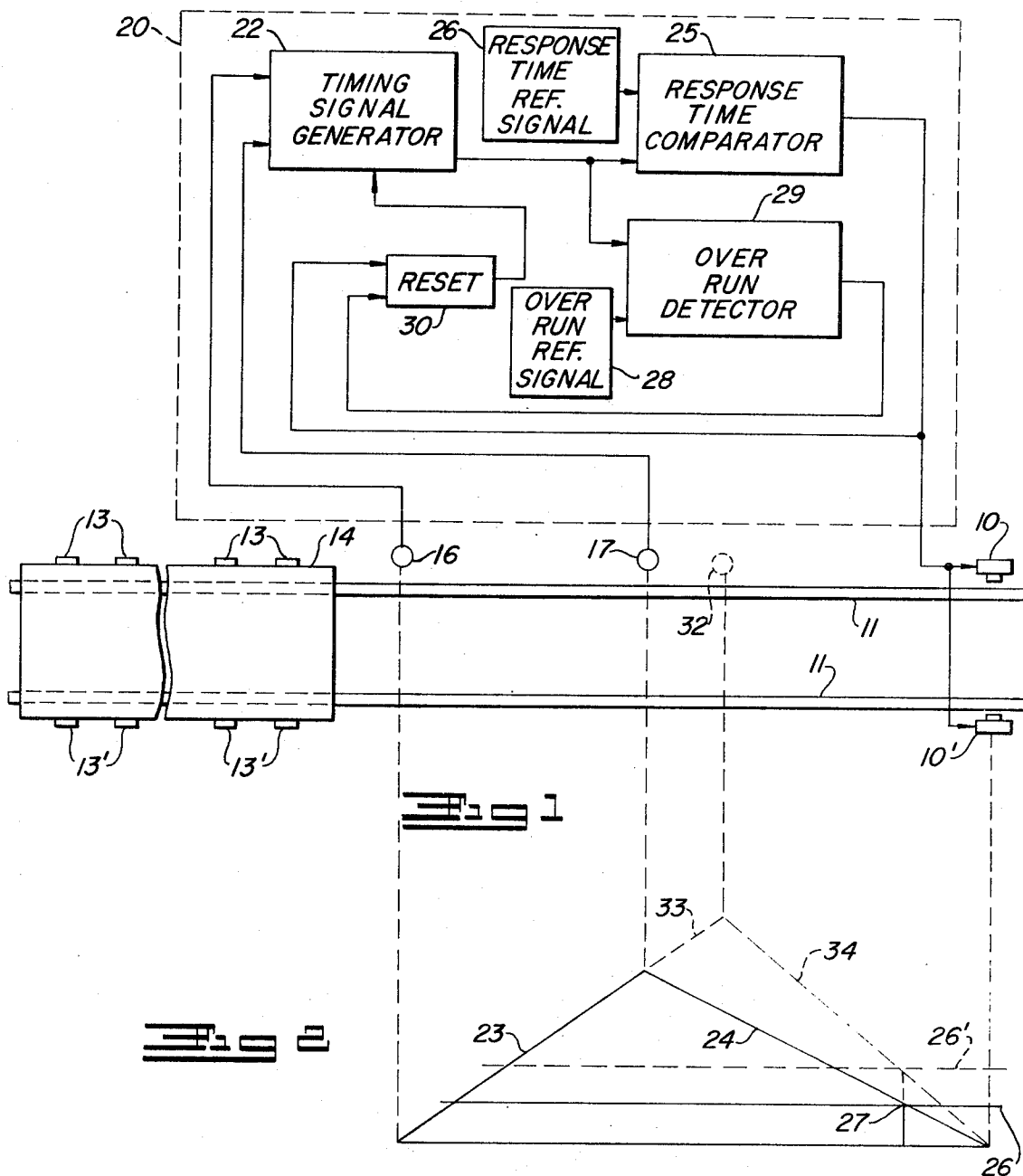
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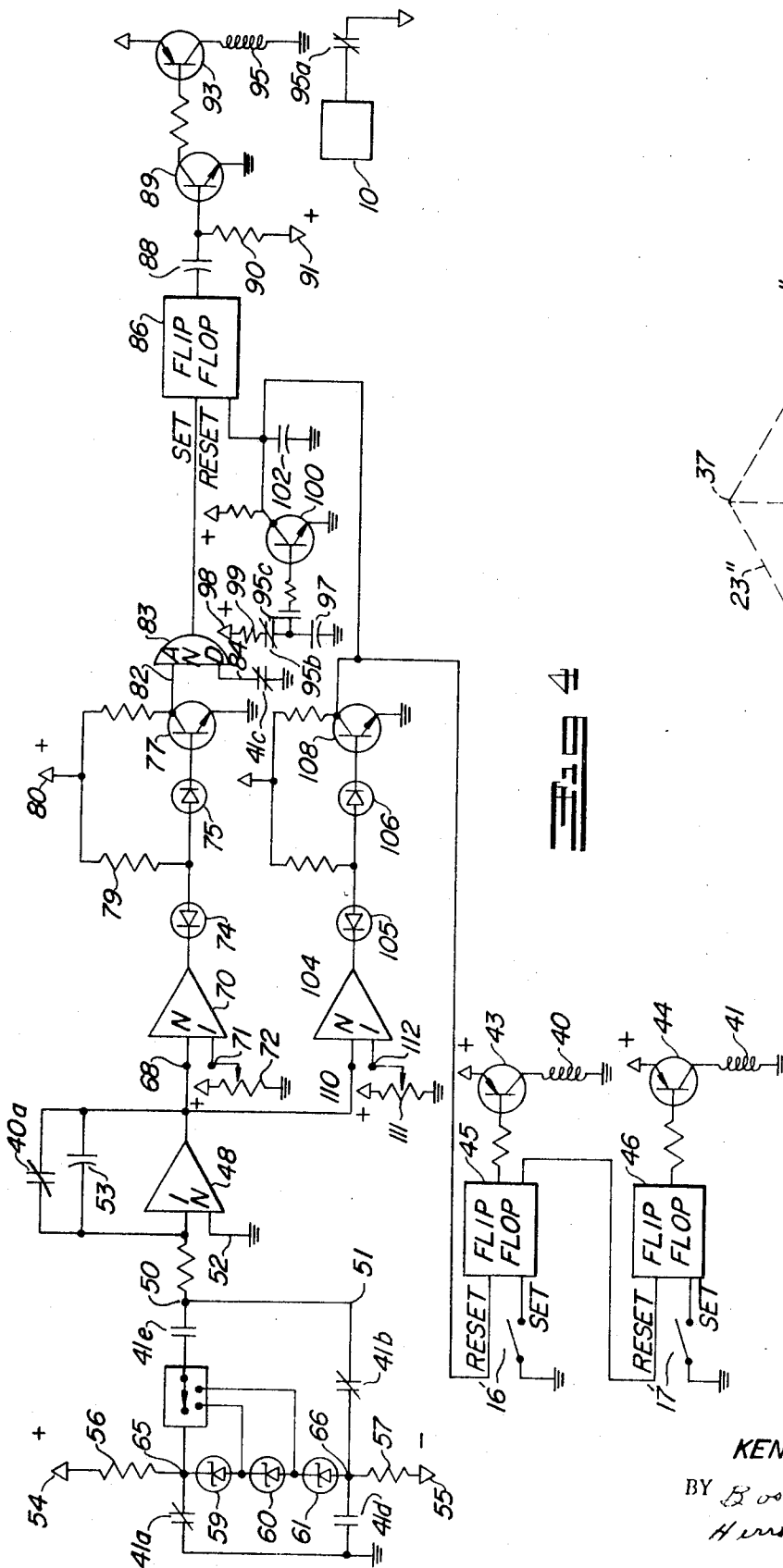
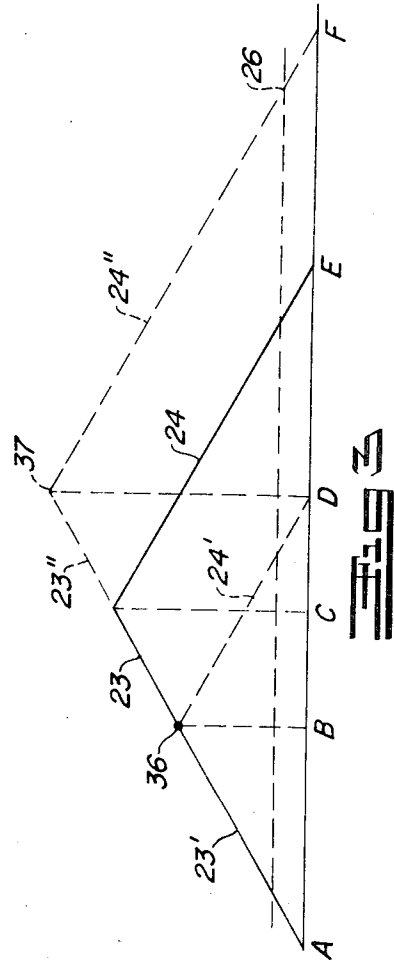
[57] **ABSTRACT**

Apparatus and method for automatically servicing the journal boxes of railroad cars moving along a track at unknown speeds. A journal box servicing device, for example, a journal box lid lifter or a journal box oiler is positioned alongside the track. Sensors detect the presence of each journal box at a first point and at a second point on the track as the car travels toward the device. The sensors are used to provide information functional of the speed of the car. This information is utilized with a reference signal which represents the response time of the journal box servicing device to transmit an actuating signal to the servicing device at the proper time in advance of the arrival of the journal box at the servicing device so that the operation of the device is substantially synchronized with the arrival of the journal box at the device. Another reference signal is also supplied to the system that prevents giving of the actuating signal to the servicing device in the event that the travel time of the car and the journal box between the first point and the second point exceeds a predetermined maximum.

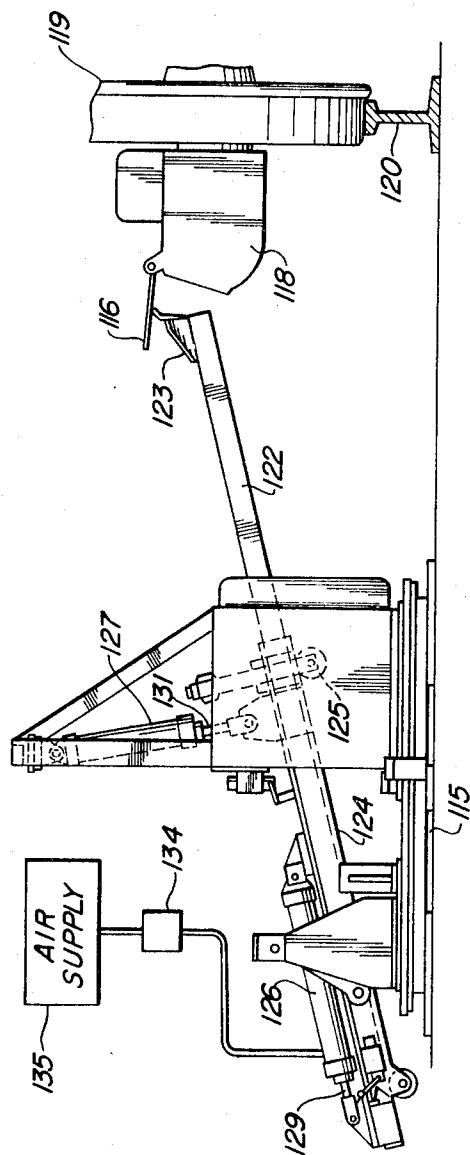
18 Claims, 5 Drawing Figures



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APPARATUS AND METHOD FOR AUTOMATICALLY SERVICING JOURNAL BOXES OF RAILROAD CARS

BACKGROUND OF THE INVENTION

This invention relates to devices for servicing the journal boxes of railroad cars and more particularly to a method and apparatus for automatically actuating such devices to cause them to service journal boxes on moving railroad cars.

The axle bearings of most railroad cars, particularly freight cars, are supplied with lubricants from a journal box located at the center of each wheel. Each journal box is provided with a spring loaded cover which is lifted, manually or automatically to allow oil to be injected, again manually or automatically, into the journal box. Proper maintenance of the axle bearings, including lubrication, is, of course, of the greatest importance. Failure of the bearings to receive adequate and timely lubrication can result in hot boxes, a primary cause of freight train delays.

For oiling journal boxes manually, the practice has been to position men on each side of the moving cars in a train to open the journal box lids, inject oil into the open journal boxes and close each lid after the oiling step. It can be seen that for proper oiling of journal boxes on even the slowest moving cars (1-2 m.p.h.) several persons are required, making the task expensive and time consuming. Moreover it is possible in manual oiling for the oilers to occasionally miss journal boxes as they pass by or for the oilers to have to reload their oil containers before the train is completely serviced. Such oversights may result in hot boxes with the consequences noted above.

Previously proposed devices for automatically servicing journal boxes on moving freight cars include journal box lid lifters and journal box oilers, either separate or combined in a single apparatus. A journal box lid lifter is shown in U.S. Pat. No. 3,034,453 to Carleton D. Tilden, a journal box oiler in U.S. Pat. No. 3,375,902 to Stephen C. Perry and a combined lid lifter and oiler in U.S. Pat. No. 3,155,199 to Glenn W. Nelson. Previously proposed devices, including those in the above identified patents, include a sensor that generates an actuating signal for the device. The sensor is placed a given distance ahead of the device to compensate for the response time of the device. A major disadvantage in this arrangement is that the response time of the particular device is constant while different trains, though each travels at substantially constant speed, may approach the device at different speeds, typically in the range of 2-5 m.p.h. The synchronization between the operation of the device and the arrival of the journal box may be correct for one particular train speed but at different train speeds a journal box lid may not be lifted or oil may not be dispensed at the proper time. Such failures again may result in hot boxes with attendant consequences.

SUMMARY OF THE INVENTION

A general object of this invention is to provide a method and apparatus for automatically and reliably servicing the journal boxes of a railroad car moving along a track at unknown, substantially constant speed. A more particular object is to provide method and apparatus for synchronizing the operation of a journal box servicing device having a known response time with the arrival alongside the device of a journal box on a moving railroad car.

Another object is to provide such a synchronizing method and apparatus in which the synchronization process is terminated to eliminate undesirable operation of the servicing device if the railroad car is halted or excessively delayed as it moves toward the device.

The method of synchronizing the operation of a journal box servicing device having a known response time to an actuating signal with the arrival alongside the device of a journal box on a moving railroad car is preferably initiated by determining the speed of the railroad car as it approaches the servicing device. The speed of the car is then used to predict the time of arrival of the journal box at the servicing device and an actuating signal is sent to the device in advance of the time of arrival by an amount equal to the response time of the device.

The two journal boxes of the frontmost pair of directly opposite wheels on the railroad car are serviced simultaneously by servicing devices on opposite sides of the track. The operation of the two servicing devices may be synchronized together or separately depending upon the difference, if any, in their respective response times as will be explained more fully below. The synchronization process is repeated for the succeeding journal boxes and all journal boxes on the same side of a car are serviced by the same servicing device.

A preferred embodiment of synchronizing apparatus according to this invention includes first and second journal box sensing means spaced apart from each other and from a servicing device along a railroad track in the path of an approaching railroad car. The distance between the two sensing means is in known ratio to the distance between the second sensing means and the servicing device. Means are provided to measure the transit time of a journal box between the first and second sensing means whereby the transit time of the journal box between the second sensing means and the servicing device is known. Means are provided for measuring the time the journal box is in transit from the second sensing means toward the servicing device to determine the time required for the journal box to reach the servicing device. Signal producing means sends an actuating signal to the servicing device when the time required for the journal box to reach the device is equal to the response time of the device.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a block diagram of a preferred embodiment of the automatic journal box servicing apparatus of this invention positioned alongside a railroad track for servicing the journal boxes of an approaching railroad car.

FIG. 2 is a diagram of two exemplary sets of ramp timing signals employed to time the travel of a journal box on a railroad car and illustrating the correlation between the duration and maximum value of the signals and the spacing of the sensors and servicing devices in FIG. 1 for a railroad car traveling at one unknown speed.

FIG. 3 is a diagram of the respective ramp timing signals for three railroad cars moving at different speeds toward the servicing devices.

FIG. 4 is a combined schematic and block diagram of a preferred embodiment of the synchronizing apparatus of this invention.

FIG. 5 is a side elevation of a journal box lid lifter that is suitable for use in the automatic journal box servicing apparatus of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the method and apparatus of this invention will be described for synchronizing the operation of a journal box servicing device positioned alongside a track in a railway yard with the arrival alongside the device of a journal box on a moving railroad car.

FIG. 1 illustrates two journal box servicing devices 10, 10' that are positioned alongside a railroad track 11 in a railway yard to service the journal boxes 13, 13' on opposite sides of an approaching railroad car 14. Car 14 has front and rear trucks (not shown) each having four wheels and four journal boxes. The response time of the servicing device is fixed while different railroad cars or different trains may approach the device at different speeds, usually within the rate of 2 to 5 miles per hour. The servicing device may be, for example, a journal box lid lifter or a journal box oiler.

A first sensor 16 and a second sensor 17 are spaced along the track from the devices 10, 10' in the direction of the approaching railroad car 14. The speed of car 14 between sensor 16 and devices 10, 10' is substantially constant, although not known. The spacing between sensors 16 and 17 and between sensor 17 and devices 10, 10' is shown greatly enlarged with respect to the dimensions of car 14. In practice sensor 16 is located so that the distance between it and devices 10, 10' is less than the distance between the front and rear journal boxes

on each truck of car 14 for reasons which will appear more fully below. The sensors 16 and 17 are located so that the ratio of the distance between sensor 16 and sensor 17 to the distance between sensor 17 and the servicing devices is known. In most cases the actual distances from sensor 16 to sensor 17 and from sensor 17 to devices 10, 10' will themselves be known but it is required only that the ratio of the distances be known. Preferably sensor 17 is located midway between sensor 16 and devices 10, 10' but it is not necessary that this be so and sensor 17 is positioned to illustrate the general case. The distance between sensor 17 and, in the preferred case, both sensor 16 and devices 10, 10' is preferably about 25 inches.

Sensors 16, 17 are preferably proximity switches such as model 11FB42 manufactured by Honeywell Inc., but may be any suitable devices for detecting the passing of a wheel of car 14, as for example, optical sensors which respond to the interruption of a light beam by a passing wheel of car 14, or that detect light reflected from a wheel of car 14.

Each sensor 16, 17 provides a signal to synchronization apparatus generally designated 20 which in turn transmits an actuating signal to servicing devices 10, 10' at the proper time. Synchronization apparatus 20 in effect determines the speed of car 14 between sensors 16 and 17, utilizes the speed to predict the time of arrival of the journal boxes alongside servicing devices 10, 10' and sends an actuating signal to the servicing devices in advance of the time of arrival by an amount equal to the response time of the devices.

The frontmost journal boxes on the front truck of car 14 are first serviced and then the following journal boxes in turn. The spacing between sensor 16 and servicing devices 10, 10' is less than that between the front and rear wheels of each truck of car 14 so that the synchronization apparatus 20 has completed the synchronization process for servicing the front journal boxes before the rear wheel actuates sensor 16 to initiate the synchronization process for servicing the rear journal boxes. Also, the speed at which car 14 is traveling (2-5 m.p.h.) is sufficiently low that servicing devices 10, 10' can be actuated, service the front journal boxes of the particular truck and return to their rest position before receiving an actuating signal to service the rear journal boxes. Since the synchronization process is the same for all journal boxes the description below applies equally well to all.

As long as the response times of servicing devices 10 and 10' are substantially equal the same actuating signal may be transmitted to both devices. If, however, the two response times are not substantially equal then separate signals must be provided as will be explained more fully below.

In FIG. 1 the signal from sensor 16 is fed into a timing signal generator 22 to produce a timing signal that increases at a known rate. Preferably, the timing signal is a "ramp" signal, so called because it increases linearly with time and so has the appearance of a ramp as shown at 23 in FIG. 2. The magnitude of ramp signal 23 at any point is proportional to the time a journal box 13, 13' on railroad car 14 has been in transit from sensor 16 toward sensor 17. Ramp signal 23 continues to increase in magnitude until sensor 17 detects the passage of the same journal box.

The signal from sensor 17 terminates ramp signal 23 and initiates another ramp signal 24 (FIG. 2) having a slope that is in known ratio to that of ramp signal 23 and opposite in sign. The ratio of the slope of signal 24 to that of signal 23 is the same as the ratio of the distance between sensor 16 and sensor 17 to the distance between sensor 17 and servicing devices 10, 10', as will be explained more fully below.

Ramp signal 24 is entered into a response time comparator 25 where its amplitude is compared to a response time reference signal 26 the magnitude of which, at the slope of ramp signal 24, represents the response time of servicing devices 10, 10'. When the magnitude of ramp signal 24 is equal to response time signal 26 as shown at 27 in FIG. 2 response time comparator 25 causes an actuating signal to be sent to servicing devices 10, 10'.

If the time required for the journal box to travel from sensor 16 to sensor 17 is excessively long because, for example, car 14 has been forced to stop between sensor 16 and sensor 17 ramp signal 23 will exceed an overrun reference signal 28 and an overrun detector 29 will cause a reset circuit 30 to reset timing signal generator 22 for reasons that will appear more fully below.

Referring more particularly to FIG. 2 ramp signal 23 increases at a known rate during the time a journal box is carried by car 14 from sensor 16 to sensor 17. Knowing the ratio of the distance between sensor 16 and sensor 17 to the distance between sensor 17 and servicing device 10 and assuming that car 14 travels at the same average speed over the two distances, the slope of ramp signal 24 required to cause it to reach zero when journal boxes 13 are directly alongside servicing devices 10, 10' is equal to the slope of ramp signal 23 times the ratio of the distance between sensor 16 and sensor 17 to the distance between sensor 17 and the servicing devices.

Knowing the response time of servicing devices 10, 10' the magnitude of reference signal 26 required to cause an actuating signal to be sent to the devices at the proper time is equal to the slope of ramp signal 24 in volts per second times the response time of devices 10, 10'.

If the response times of servicing devices 10, 10' are not substantially equal a separate actuating signal must be provided to servicing device 10'. To supply the signal an additional response time reference signal (not shown) corresponding to the response time of device 10' at the slope of ramp signal 24 is compared in an additional response time comparator (not shown) to ramp signal 24. When ramp signal 24 is equal to the reference signal an actuating signal is sent to servicing device 10'. Except for this possible variation the operation of synchronizing apparatus 20 is the same whether it provides an actuating signal to one or both servicing devices 10, 10'. The remaining description, then, will encompass one synchronizing apparatus 20 as shown in FIG. 1 providing an actuating signal to one servicing device 10.

The preferred spacing of sensors 16, 17 and servicing device 10 is illustrated in FIG. 1 where sensor 17 in dashed lines is located further toward servicing device 10 at a position 32 midway between sensor 16 and servicing device 10. In that case ramp signal 23 continues to increase in magnitude until the particular journal box on car 14 is detected by sensor 17 at its new location as indicated by the dashed line 33 in FIG. 2. The slope of ramp signal 34 should then be equal in magnitude and opposite in sign to that of ramp signal 23 and its extension 33. The magnitude of the reference voltage 26' required to cause an actuating signal to be sent to servicing device 10 at the proper time is determined from the slope of the ramp signals.

It should be noted that the correlation between the distances in FIG. 1 and the duration and maximum value of the signals in FIG. 2 as illustrative only of car 14 traveling along tracks 11 at one speed. Another railroad car approaching servicing device 10 at a speed different from that of car 14 would require more or less time to travel the distances from sensor 16 to sensor 17 and from sensor 17 to device 10.

FIG. 3 illustrates the ramp signal for three railroad cars approaching servicing device 10 at different speeds but with the spacing between sensors 16 and 17 and servicing device 10 and the slope of the ramp signals identical for all three cars. Ramp signals 23 and 24 represent the intermediate speed and are essentially as shown in FIG. 2. The time required for a journal box on a railroad car 14 to travel the distance between sensor 16 and sensor 17 is represented by the distance AC in FIG. 3 and the time required to travel the distance between sensor 17 and device 10 is represented by the distance CE.

For a railroad car approaching servicing device 10 at a greater speed the time required to travel the two distances would be less and is represented by the distances AB and BD. Since the transit time is shorter ramp signal 23' attains a lower maximum voltage indicated at 36.

For a railroad car approaching servicing device 10 at a lesser speed the time required to travel the distances between sensors 16 and 17 and sensor 17 and device 10 is greater and is represented in FIG. 3 by the distances AD and DF respectively. Since ramp signal 23 continues at the same slope for a longer time period as indicated at 23'' the maximum voltage attained is higher as indicated at 37. In each case reference voltage 26 is the same and at the slope of declining ramp signals 24, 24', 24'' represents the response time of servicing device 10.

It should be noted from FIG. 3 that if the time a railroad car travels from sensor 16 to sensor 17 is excessively long, ramp signal 23'' will tend to increase until, as a practical matter, apparatus limitations may appear, disrupting the synchronizing process and, perhaps, causing operation of servicing device 10 at an improper time. In some instances unsynchronized operation could produce undesirable results. For example, servicing device 10 could be operated at an improper time, and if it were an oiler, cause oil intended for journal boxes 13 to fall on railroad track 11.

To remedy this situation the overrun detector 29 (FIG. 1) provides a reset to timing signal generator 22 when ramp signal 23 exceeds overrun reference signal 28 which represents a maximum normal transit time between sensors 16 and 17. The synchronizing system is thus reset and the servicing device will not be actuated at an improper time with, perhaps, unhappy results.

In FIG. 4, a preferred embodiment of the apparatus of this invention is shown schematically in detail and includes relays 40 and 41 actuated by conduction of transistors 43 and 44 respectively which are conductive during the "set" state of flip-flops 45 and 46 respectively. Flip-flops 45 and 46 each have two stable states, set and reset, and are set by switches 16' and 17' respectively which correspond to sensors 16 and 17 in FIG. 1.

Relay 40 is provided with a normally closed contact 40a. Relay 41 is provided with normally closed contacts 41a, 41b and 41c and with normally open contacts 41d and 41e.

A ramp signal generator in the form of an operational amplifier 48 connected as an integrator has one signal input 50 connected to an integrating signal circuit generally designated 51 and another input 52 connected to ground reference. An integrating capacitor 53 is connected as a feedback element across operational amplifier 48, and normally closed contacts 40a of relay 40 provide a bypass around capacitor 53 when relay 40 is not actuated.

So long as contacts 40a remain closed amplifier 48 is effectively short circuited. When contacts 40a are open the output voltage of amplifier 48 is proportional to the integral of the input voltage as is well known in the art. A constant DC signal to input 50 of amplifier 48 will produce a linear ramp signal at the output, the slope of which is directly proportional to the magnitude of the input signal but opposite in sign.

Integrating signal circuit 51 operates to connect input 50 of amplifier 48 alternately to one and then the other of two DC signals of opposite polarity and in known ratio of magnitudes. A positive voltage supply 54 and a negative voltage supply 55 are connected through resistors 56 and 57 and zener diodes 59, 60 and 61 to form a precision voltage divider. The zener breakdown voltages of the zener diodes 59, 60 and 61 are preferably equal, and the voltage at the cathode of each zener diode bears a known relation to the voltage at the cathode of any of the other zener diodes. A selector switch 63 connects input 50 of amplifier 48 through contacts 41e to the cathode of a selected zener diode.

So long as the contacts of relay 41 are in their normal positions as shown, point 65 of integrating signal circuit 51 is connected directly to ground through contacts 41a and input 50 of amplifier 48 is connected directly to point 66 through contacts 41b. The voltage level at point 66 is the sum of the voltages across zener diodes 59, 60 and 61 and is negative in polarity. Under these conditions if amplifier 48 is allowed to integrate the signal at point 66 a positive going ramp signal

will be produced at the output of amplifier 48, the slope of that signal being proportional to the magnitude of the voltage at point 66.

If relay 41 is actuated, point 66 will be connected directly to ground through contact 41d, and input 50 of amplifier 48 will be disconnected from point 66 and will be connected to point 65 through contact 41e and switch 63. Under those conditions the voltage level at point 65 will be equal to the sum of the voltages across zener diodes 59, 60 and 61 and will be positive in polarity. Thus, the signal at point 65 will be equal in magnitude but opposite in polarity to that at point 66 under the previous conditions. By changing the position of switch 63 a voltage level may be selected which is a known portion of the voltage at point 65, for example, two-thirds or one-third of the voltage at point 65. Since the slope of the output signal from amplifier 48 is proportional to the magnitude of the input signal a slope may be selected which bears a known relation to that of the previous output signal.

The output of amplifier 48 is coupled to input 68 of a comparator in the form of a differential operational amplifier 70. Another input 71 of amplifier 70 is connected to a variable reference voltage 72 by which a reference signal 26 (FIGS. 2 and 3) is selected which at the slope of declining ramp signal 24 (FIGS. 2 and 3) corresponds to the response time of the servicing device 10.

The output of amplifier 70 is connected through oppositely facing diodes 74 and 75 to a transistor 77. Current is supplied to diode 74 and 75, and through diode 75 to transistor 77, through a resistor 79 from a positive voltage supply 80. Diode 74 is rendered conductive or nonconductive in response to the output voltage of differential amplifier 70.

Amplifier 70 is an operational amplifier. Such amplifiers normally have a feedback circuit which determines its operating characteristics provided that the gain of the amplifier with the feedback circuit disconnected is very high, all of which is well known in the art. Amplifier 70 has no feedback circuit but is a differential amplifier having very high gain. As a result the amplifier is easily driven to saturation and operates as a bistable device having a high voltage output state and a low voltage output state.

Transition between the two states is effected by the voltage at input 68 becoming more positive or less positive than the reference voltage at input 71. When the voltage at input 68 becomes more positive than the reference voltage at input 71, the output voltage rises immediately to its more positive state where it remains until the voltage at input 68 becomes less positive than the reference voltage at input 71. At that time the output voltage returns to its less positive state.

When the output voltage of amplifier 70 is at its less positive level diode 74 is rendered conductive and diode 75 is rendered nonconductive which in turn renders transistor 77 nonconductive. When the output voltage of output amplifier 70 is at its more positive level diode 74 is rendered nonconductive, diode 75 is rendered conductive, and transistor 77 is rendered conductive.

The collector of transistor 77 is connected to input 82 of AND-gate 83 which has another input 84 connected through normally closed contact 41c to ground. The output of AND-gate 83 is connected to the "set" input of a flip-flop 86 which has two stable states, set and reset. AND-gate 83 produces an output signal of the proper level to set flip-flop 86 when both input 82 and input 84 are open, or are connected to a positive voltage.

The output of flip-flop 86 is coupled through capacitor 88 to the base of a transistor 89 which is normally biased into conduction by current flowing through resistor 90 from positive voltage supply 91. The collector of transistor 89 is connected to the base of another transistor 93 and maintains that transistor in conduction. A relay 95 is maintained actuated so long as transistor 93 remains conducting. Relay 95 is provided with normally closed contacts 95a and 95b and normally open contacts 95c. Since relay 95 is normally actuated contacts 95a and 95b are open in their quiescent operating state while contact 95c is closed.

When flip-flop 86 is switched from its reset, or more positive state, to its set, or less positive state by AND-gate 83 the negative voltage transition from flip-flop 86 is coupled through capacitor 88 and renders transistor 89 nonconductive for a time determined by the RC time constant of capacitor 88 and resistor 90. Transistor 89 in turn renders transistor 93 nonconductive and causes relay 95 to release momentarily. During that time, contact 95a closes and sends an actuating signal to servicing device 10.

Contacts 95b and 95c are used to reset flip-flops 45, 46 and 86 when relay 95 is again actuated after its momentary release. When relay 95 is released contact 95b closes and allows a capacitor 97 to be charged from a positive voltage supply 98 through a resistor 99. When relay 95 again becomes actuated at the end of its momentary release, contact 95b opens and contact 95c closes to connect capacitor 97 to the base of a transistor 100. Transistor 100 is thereby rendered conductive for a short time and provides a reset signal to flip-flops 45, 46 and 86.

The resetting of flip-flops 45 and 46 renders transistors 43 and 44 nonconductive thereby releasing relays 40 and 41 to place the system in its original condition receptive to signals from sensors 16 and 17. The release of relay 41 closes contacts 41c, disabling AND-gate 83 and removing the set signal from flip-flop 86. A capacitor 102 ensures that flip-flop 86 is reset by maintaining the reset signal from transistor 100 at the reset input of flip-flop 86 after the set signal from AND-gate 83 has been removed.

The operation of the synchronizing apparatus is as follows: Switch 63 will have been set for the proper ratio of slopes of the ramp signals to correspond with the spacing of sensors 16 and 17 and servicing device 10 and reference voltage 72 will have been adjusted to correspond to the response time of device 10 at the selected slope of ramp signal 24. It will be apparent that in a given location the spacing between sensors 16 and 17 and servicing device 10 will not be changed except under very unusual circumstances. The settings of switch 63 and reference voltage 72 will therefore not ordinarily be changed and they may be secured to their selected positions by suitable means to avoid being changed accidentally.

The wheel of the approaching railroad car is detected by switch 16' which sets flip-flop 45 causing actuation of relay 40. Contacts 40a open and allow operational amplifier 48 to integrate the DC signal appearing at point 66 in integrating signal circuit 51 producing at the output of amplifier 48 a positive going ramp signal 23 as shown in FIGS. 2 and 3. When the magnitude of the ramp signal exceeds reference signal 72 at input 71 of amplifier 70 the output of amplifier 70 switches to its more positive state cutting off diode 74 causing transistor 77 to conduct. At this time, however, no signal passes through AND-gate 83 since it is disabled by contacts 41c.

When the same wheel of the approaching railroad car is detected by switch 17', relay 41 is actuated and causes integrating signal circuit 51 to present a DC signal of opposite polarity and in the proper ratio of magnitude to that previously integrated to input 50 of amplifier 48. Amplifier 48 then generates the oppositely directed ramp signal 24 as shown in FIGS. 2 and 3. The magnitude of the ramp signal is compared to reference signal 72 in amplifier 70. When the ramp signal becomes more negative than reference signal 72 the output of amplifier 70 switches to its less positive state rendering diode 74 conductive and transistor 77 nonconductive. The signal from transistor 77 passes through AND-gate 83, which was enabled by the opening of contacts 41c at the time switch 17' was actuated, to the set input of flip-flop 86.

The set signal to flip-flop 86 produces an output which renders transistors 89 and 93 nonconductive and releases relay 95 for a short time as described above. The momentary release of relay 95 produces an actuating pulse to servicing device 10 through contact 95a. When relay 95 is again actuated transistor 100 is rendered conductive for a short time and resets flip-flops 45, 46 and 86 in the manner described above.

As noted above if the time in transit of railroad car 14 between sensors 16 and 17 becomes excessively long the mag-

nitude of the ramp signal from operational amplifier 48 may reach a practical upper limit which may result in the transmission of an actuating signal to servicing device 10 at an improper time.

To prevent such a situation the positive going ramp signal from amplifier 48 is entered into an overrun detector comprising differential operational amplifier 104, diodes 105 and 106, and transistor 108. Operational amplifier 104 is identical to operational amplifier 70 described above and operates in the same manner. Likewise the circuit comprising diode 105 and transistor 108 operates in the same manner as the circuit described above comprising diodes 74 and 75 and transistor 77.

The ramp signal from amplifier 48 is entered into input 110 of amplifier 104 and is compared to a reference signal 111 connected to input 112. Reference signal 111 is variable to represent the maximum normal transit time between sensor 16 and sensor 17 for the particular conditions of use. If the magnitude of the ramp signal from amplifier 48 becomes greater than the reference signal at input 112 the output of amplifier 104 switches to its more positive state rendering diode 105 nonconductive and allowing current to flow through diode 106 to the base of transistor 108. Transistor 108 is thereby rendered conductive and transmits a reset signal to flip-flops 45, 46 and 86 to return the system to its original condition. So long as the magnitude of the ramp signal from amplifier 48 does not exceed reference signal 111 the output of amplifier 104 remains in its less positive state and transistor 108 remains nonconducting.

While it is apparent that if the apparatus is reset under these conditions the particular journal box will not be serviced by device 10, this is preferable to actuating device 10 at an improper time which could cause other difficulties as discussed above in addition to the particular journal box not being serviced.

FIG. 6 shows as one example of servicing device 10 a lid lifter generally designated 115 suitable for use with this invention for lifting the lid 116 of a journal box 118 on the wheel 119 of a railroad car traveling along a rail 120. Lid lifter 115 is illustrated and described in detail in U.S. Pat. No. 3,034,453 to Carleton D. Tilden assigned to the predecessor of the assignee of this invention.

The lid lifter has an elongated reciprocating tongue 122 which terminates in a spade-shaped lifting member 123. Tongue 122 slides within a supporting carriage 124 on rollers 125, and is driven by pneumatic cylinders 126 and 127. Admitting air to cylinder 126 in such a manner as to cause piston rod 129 to move to the right as viewed forces tongue 122 to move from left to right within carriage 124. This outward movement of tongue 122 positions the spade-shaped member 123 to lift lid 116. Movement of piston rod 129 in the opposite direction correspondingly causes retraction of tongue 122. Admitting air to cylinder 127 in such a manner as to cause piston rod 131 to move upward lifts carriage 124 and tongue 122 upwardly. The combination of inward and upward movement imparted to tongue 122 by cylinders 126 and 127 causes the spade-shaped lifting member 123 to lift lid 116. The actuating signal from relay 95 causes operation of a valve 134 between an air supply 135 and cylinder 126 to initiate the lid lifting operation.

As noted above, servicing device 10 may be a journal box oiler that dispenses oil into the open journal boxes of moving railroad cars. Such oilers are well known and take many forms. Any oiler adapted to receive an actuating signal in the form of an electrical signal or a contact closure may be used with the automatic journal box servicing apparatus of this invention.

Ideally a journal box lid lifter and a journal box oiler may be spaced apart along a railroad track to service the journal boxes of passing cars, the operation of each device being synchronized with the passing of the journal boxes by its own associated synchronizing apparatus and sensors. In this manner the journal boxes would be serviced automatically in one pass by the servicing devices.

While this invention has been shown and described for synchronizing the operation of a journal box servicing device with the arrival alongside the device of a railroad car journal box, it is apparent that the invention is not confined to such use but may be used generally for synchronizing the operation of a device with a predetermined position of a moving object.

What is claimed is:

1. The method of synchronizing the operation of a journal box servicing device having a known response time to an actuating signal with the arrival alongside the device of a journal box on a moving railroad car comprising the steps of measuring the speed of the car as it travels from a first point to a second point in advance of the servicing device, utilizing the speed to predict the time of arrival of the journal box at the device, and sending an actuating signal to the device in advance of the time of arrival by an amount equal to the response time of the device.

2. The method of claim 1 further comprising the step of terminating the synchronizing process if the speed of the car is less than a predetermined value.

3. The method of synchronizing the operation of a journal box servicing device having a known response time to an actuating signal with the arrival alongside the device of a journal box on a moving railroad car comprising the steps of measuring the time required for said journal box to travel a first distance in advance of said servicing device, utilizing the time required to travel the first distance to predict the time required to travel a second distance to reach the servicing device, the first distance being in known ratio to the second distance, subtracting from the time required to travel the second distance as the journal box travels the second distance toward the servicing device to determine the time required for the journal box to reach the device, and sending an actuating signal to the servicing device when the time required for the journal box to reach the servicing device is equal to the response time of the servicing device.

4. The method of claim 3 further comprising the step of terminating the synchronizing process if the time required for the journal box to travel the first distance is greater than a predetermined time.

5. The method of synchronizing the operation of a journal box servicing device having a known response time to an actuating signal with the arrival alongside the device of a journal box on a railroad car moving along a track at unknown speed comprising the steps of,

detecting the presence of said journal box at a first point on said track,

detecting the presence of said journal box at a second point on said track between said first point and said servicing device, the distance from said first point to said second point being in known ratio to the distance between said second point and said device,

producing a timing signal that increases at a known rate in response to the presence of the journal box at said first point and decreases in response to the presence of the journal box at said second point at a rate bearing the same ratio to the rate of increase as the ratio of the distance between said first point and said second point to the distance between said second point and said servicing device,

comparing said decreasing timing signal to a first reference signal having a magnitude which, at the rate of decrease of said timing signal, is indicative of the response time of said servicing device, and

producing an actuating signal to said device when said decreasing timing signal is equal to said first reference signal.

6. The method of claim 5 further comprising the steps of comparing said increasing timing signal to a second reference signal having a magnitude which, at the rate of increase of said timing signal, represents a predetermined maximum normal

time required for said journal box to travel from said first point to said second point, and terminating said timing signal when said increasing timing signal is equal to said second reference signal.

7. The method of claim 5 wherein said timing signal is a ramp signal.

8. Apparatus for synchronizing the operation of a journal box servicing device having a known response time to an actuating signal with the arrival alongside the device of a journal box on a railroad car moving at unknown speed comprising:

first sensing means for producing a first signal indicating the presence of said journal box at a first point on said track spaced from said servicing device in a direction opposite the direction of movement of said railroad car,

second sensing means for producing a second signal indicating the presence of said journal box at a second point on said track between said first point and said servicing device, the distance from said first point to said second point being in known ratio to the distance between said second point and said servicing device,

first means actuated by said first signal for measuring the transit time of said journal box from said first point to said second point, whereby the transit time of said journal box between said second point and said servicing device is known,

second means actuated by said second signal for measuring the time said journal box is in transit from said second point toward said servicing device to determine the time required for said journal box to reach said device, and

means for producing an actuating signal to said servicing device when the time required for said journal box to reach said device is equal to the response time of said device.

9. The apparatus of claim 8 wherein said first time measuring means and said second time measuring means comprises a signal generator for producing a timing signal that increases at a known rate in response to said first signal and decreases in response to said second signal at a rate bearing the same ratio to the rate of increase as the ratio of the distance between said first point and said second point to the distance between said second point and said servicing device.

10. The apparatus of claim 9 wherein said means for producing an actuating signal to the servicing device when the time required for the journal box to reach the device is equal to the response time of the device comprises a reference signal having a magnitude which, at the rate of decrease of said timing signal, is indicative of the response time of said device, and a comparator for comparing said decreasing timing signal to said reference signal to produce an actuating signal to said device when said decreasing timing signal is equal to said reference signal.

11. The apparatus of claim 8 further comprising means for terminating the operation of said first measuring means if the transit time of said journal box between said first and second points exceeds a predetermined time.

12. The apparatus of claim 11 wherein said first time measuring means and said second time measuring means comprises a signal generator for producing a timing signal that increases at a known rate in response to said first signal and decreases in response to said second signal at a rate bearing the same ratio to the rate of increase as the ratio of the distance between said first point and said second point to the distance between said second point and said servicing device, and said means for terminating the operation of said first measuring means if the transit time of said journal box between said first and second points exceeds a predetermined time comprises a reference signal having a magnitude which, at the rate of increase of said timing signal, is indicative of said predetermined time, and a comparator for comparing said increasing timing signal to said reference signal to produce a reset signal to said signal generator when said increasing timing signal exceeds said reference signal.

13. Apparatus for automatically servicing a journal box on a railroad car moving along a track at unknown speed comprising:

a journal box servicing device positioned alongside said track for servicing said journal box in response to an actuating signal, said device having a known response time to said actuating signal,

first sensing means for producing a first signal indicating the presence of said journal box at a first point,

second sensing means for producing a second signal indicating the presence of said journal box at a second point, the distance between said first point and said second point being in known ratio to the distance between said second point and said servicing device,

means for generating a ramp signal that increases in response to said first signal and decreases in response to said second signal, the ratio of the slope of said decreasing ramp signal to the slope of said increasing ramp signal being the same as the ratio of the distance between said first point and said second point to the distance between said second point and said servicing device,

a first reference signal having a magnitude which, at the slope of said decreasing ramp signal, is indicative of the response time of said device, and

means for comparing said decreasing ramp signal to said first reference signal to produce an actuating signal to said device when said decreasing ramp signal is equal to said first reference signal.

14. The apparatus of claim 13 further comprising a second reference signal having a magnitude which, at the slope of said increasing ramp signal, represents a predetermined maximum

normal time for said journal box to travel from said first point to said second point, means for comparing said increasing ramp signal to said second reference signal to produce a reset signal when said increasing ramp signal is equal to said second reference signal, and means responsive to said reset signal for resetting said first sensing means and said ramp signal generating means.

15. The apparatus of claim 13 wherein said means for generating said ramp signal comprises an integrator, a first DC signal coupled to the input of said integrator, means responsive to said first signal from said first sensing means for causing said integrator to integrate said first DC signal, a second DC signal of opposite polarity to said first DC signal, the ratio of the magnitude of said second DC signal to the magnitude of said first DC signal being the same as the ratio of the distance between said first point and said second point to the distance between said second point and said servicing device; and means responsive to said second signal from said second sensing means for switching the input of said integrator from said first DC signal to said second DC signal.

16. The apparatus of claim 13 further comprising means responsive to said actuating signal for resetting said first and second sensing means and said ramp signal generator.

17. The apparatus of claim 13 wherein said second sensing means is located midway between said first sensing means and said servicing device.

18. The apparatus of claim 13 wherein said first and second sensing means are proximity switches actuated by the railroad car wheel carrying said journal box to be serviced.

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