April 19, 1938. C. H. LAY 2,114,904

APPARATUS FOR THE CONTROL OF HIGHWAY CROSSING SIGNALS

Filed Oct. 7, 1935 2 Sheets-Sheet 1

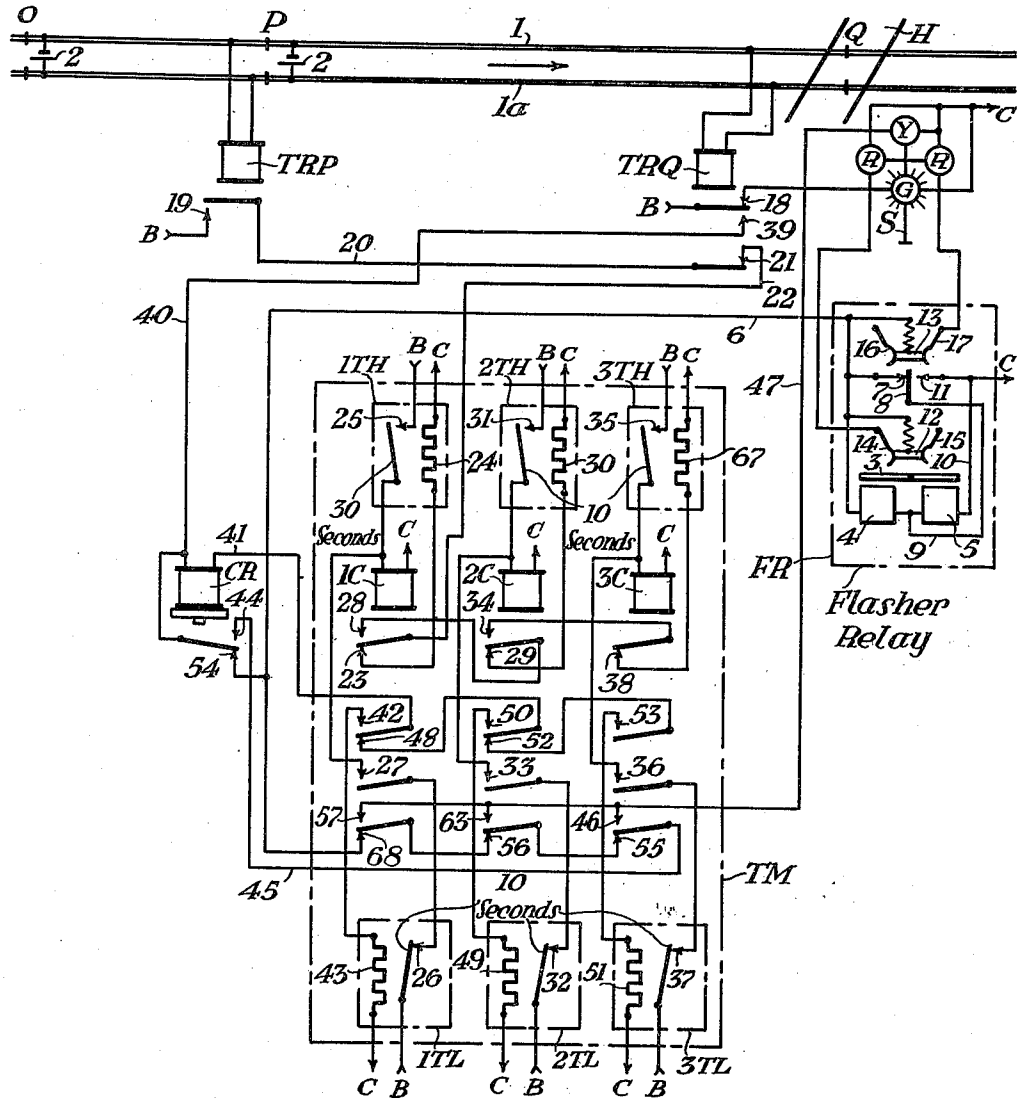


Fig. 1.

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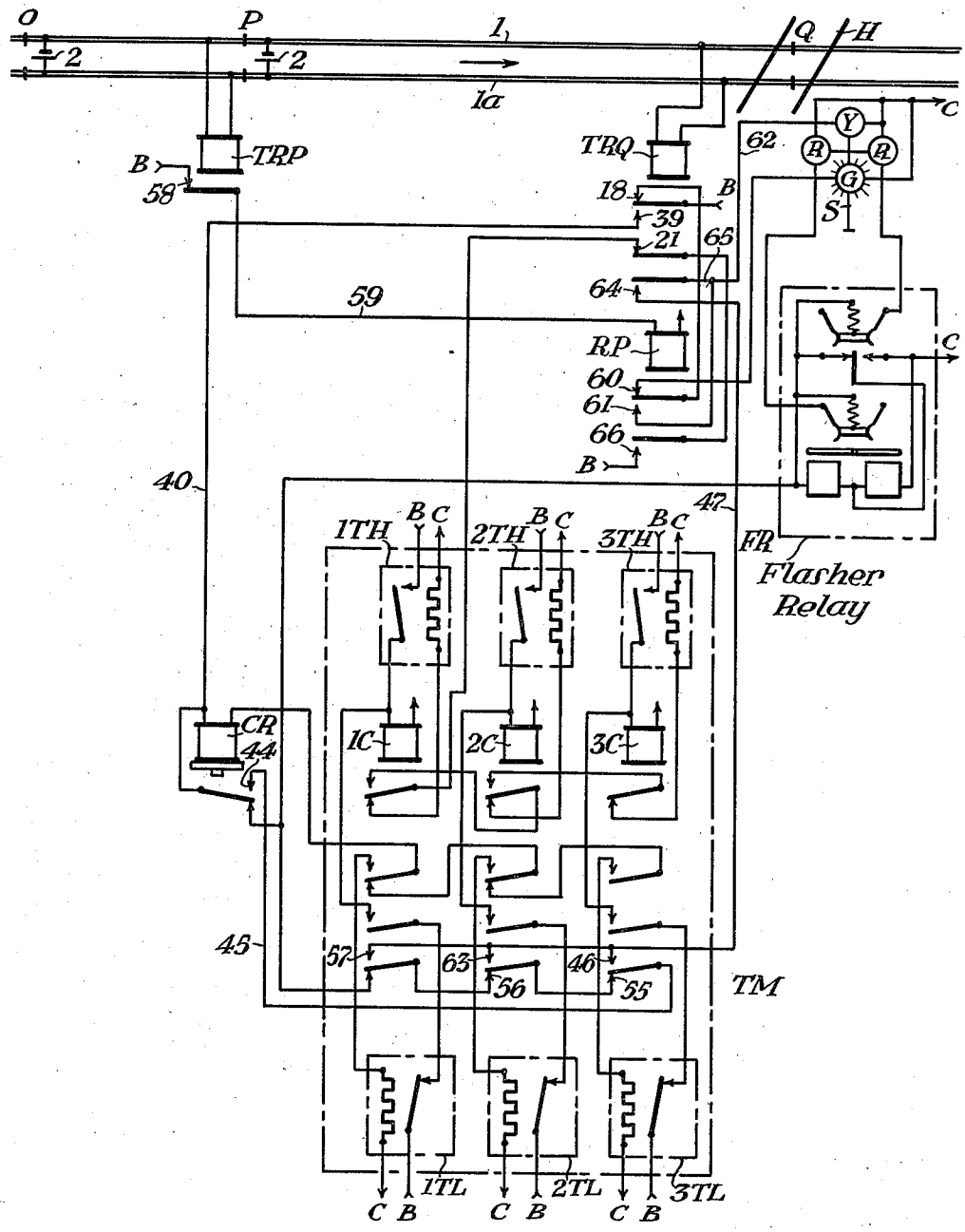


Fig. 2.

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UNITED STATES PATENT OFFICE

2,114,904

APPARATUS FOR THE CONTROL OF HIGHWAY CROSSING SIGNALS

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Application October 7, 1935, Serial No. 43,856

15 Claims. (Cl. 246—130)

My invention relates to apparatus for the control of highway crossing signals, and has for an object the provision of apparatus controlled by a train approaching the highway crossing for governing the operation of a highway crossing signal capable of displaying three separate and distinctive indications and which apparatus is effective to govern at least one of the indications in accordance with the speed of the train. Other objects and advantages of my invention will appear as the specification progresses.

I will describe two forms of apparatus embodying my invention, and will then point out the novel features thereof in claims.

For a better understanding of my invention, reference may be had to the accompanying drawings, of which Figs. 1 and 2 are diagrammatic views showing two different forms of apparatus and circuits, each embodying my invention.

Similar reference characters refer to similar parts in each of the two views.

Referring to Fig. 1, the reference characters 1 and 1a designate the track rails of a stretch of railway over which traffic normally moves in the direction indicated by the arrow and which stretch is intersected at grade by a highway H. A highway signal S is located adjacent the intersection. As here shown, this signal S consists of a green lamp G, a yellow lamp Y, and two red lamps R. The green lamp G is illuminated when no train is approaching the intersection within the limits of the stretch of railway under consideration to display a clear traffic signal to the highway users. The yellow lamp Y is illuminated when a train is approaching the intersection to warn highway users that a train is approaching and a danger or stop signal is about to be displayed. The two red lamps R are alternately flashed in the manner of the usual flashing highway crossing signals a predetermined time interval prior to the arrival of a train at the intersection to indicate stop to the highway users. Continuous illumination of either one or both red lamps is also a stop indication. It follows that the three indications of the signal S correspond to the green, yellow and red traffic lights encountered along a highway. In practicing my invention, two signals each similar to the signal S will preferably be set at the intersection facing the opposing directions so as to be plainly exhibited to highway users approaching the intersection from both directions. Since the lamps of such second signal would be arranged in multiple with the respective lamps of signal S, the second signal is not shown on the drawings for the sake of clearness. It will be understood that my invention is not limited to this one form of highway signal and other types which are capable of displaying three indications may be used if found desirable to do so.

The track rails 1 and 1a are divided by the usual insulated rail joints to form two track sections O—P and P—Q, which sections are traveled successively in the order named by a train approaching the highway H when moving in the normal direction of traffic. Each track section is provided with a track circuit comprising a source of current such as a battery 2 connected across the rails at one end of the section and a track relay designated by the reference character TR plus an exponent corresponding to the position connected across the rails at the other end of the section. For the purpose of this description, I shall refer to the track section O—P as a measuring section, and to the section P—Q as an operating section. As will appear hereinafter the time consumed by a train in passing through the measuring section is measured, and hence the speed of the train is determined. The exhibit of the Y and R lamps of signal S is governed in accordance with the measured speed after the train has entered the operating section P—Q. In order to more easily understand the apparatus embodying my invention, I shall assume a maximum speed for all trains approaching the highway H of 90 miles per hour, and that an exhibit of a stop signal for not less than 20 seconds and not more than 30 seconds prior to the arrival of a train at the intersection is desired. A train traveling at 90 miles per hour advances 2640 feet in 20 seconds, hence the operating section P—Q is approximately 2640 feet in length. The measuring section O—P may be of any convenient length and may be of the same length as the operating section. In the present case I shall assume the measuring section O—P to be substantially of the same length as the operating section. It will be understood, of course, that my invention is not limited to the above stated values of train speeds, lengths of track sections and time of exhibit of the highway signal, and such values would be selected which are best suited to the location at which the apparatus is installed.

In addition to the track circuits mentioned above, the signal control apparatus consists of a flasher relay FR, a time measuring mechanism designated as a whole by the reference character TM and a controlling relay CR.

The particular type of flasher relay is immaterial, however, for the purpose of this application,

it may be assumed that the flasher relay FR is of the type disclosed by the C. S. Snavely and W. B. Wells Reissue Patent No. 17,252. In this type of relay, a pivoted armature 3 is alternately attracted by the two operating windings 4 and 5 of the relay due to the fact that the windings are alternately short-circuited over contacts actuated by the armature 3. Assuming the relay FR to occupy its biased position as illustrated in Fig. 1 and that positive current is supplied over wire 6 in a manner to later appear, current first flows over contact 7—8 of the relay, central connection 9, winding 5 and wire 10 to the negative terminal C of the same source of current, since the winding 4 is short-circuited by the path including contact 7—8 and the central connection 9. Energization of winding 5 causes the armature 3 to be attracted toward the winding 5. Contact finger 8 is attached to armature 3 and hence is swung out of engagement with contact 7 and into engagement with a contact 11 when the armature 3 is operated in response to energization of winding 5. This movement of contact finger 8 removes the shirt circuit from winding 4 and completes a short circuit to winding 5. Current now flows from wire 6 through winding 4, central connection 9, contact 8—11 and to the negative terminal C of the current source, and winding 4 is energized to attract the armature 3. Thus, the contact finger 8 is now swung away from the contact 11 and back into engagement with the contact 7. The parts are so proportioned and adjusted that armature 3 oscillates at say 30 cycles per minute as long as current is thus supplied to the relay. Two circuit controlling contact members 12 and 13 are operatively connected with armature 3 and oscillate therewith, the arrangement being such that contact member 12 alternately breaks engagement with stationary contacts 14 and 15 and contact member 13 alternately breaks engagement with stationary contacts 16 and 17 in step with the cyclic operation of armature 3. The function of the flasher relay FR will appear when the operation of the apparatus of Fig. 1 is described.

The time measuring mechanism may take different forms several of which are well known to the art. As here shown the time measuring mechanism is that disclosed in my copending application Serial No. 62,968, filed February 8, 1936, for Controlling apparatus for highway crossing signals. This time measuring mechanism TM comprises two series of individual timing devices and a chain of control relays, there being a control relay which cooperates with a particular device of each of the series of timing devices. The separate timing devices of the first series successively pick up the chain of control relays while a train approaching the highway occupies the measuring track section. Each control relay once picked up is retained energized over a stick circuit. The separate timing devices of the second series are used to successively release the chain of control relays after the train has entered the operating section. Operation of the highway signal is governed in part by this chain of control relays. As here shown, three separate timing devices are provided for each series and are of the thermal relay type. The devices designated 1TH, 2TH and 3TH constitute the first series, and the devices designated 1TL, 2TL and 3TL constitute the second series. Although only three devices are here provided for each series it will be understood each series may consist of any desired number of such devices. These thermal relays are of the type which actuate a circuit controlling contact when the heater element of the relay has been supplied with current for a predetermined time interval. The operating interval of each of the different thermal relays is indicated on the drawings and these intervals are selected to secure at least twenty seconds and not over thirty seconds display of the stop indication of the highway signal prior to the arrival of a train at the intersection when the lengths of the respective track sections and speed of trains are as assumed hereinbefore. The relays of the associated chain are designated by the reference characters 1C, 2C and 3C and each of these relays is of the direct current neutral type.

The controlling relay CR is preferably of the direct current neutral type and is slightly slow releasing in character.

In describing the operation of the apparatus of Fig. 1, I will first assume no train is approaching the highway H, that is, the track sections O—P and P—Q are both unoccupied, and that the apparatus occupies the position illustrated in the drawings. Under these conditions, the green lamp G of signal S is illuminated by virtue of a circuit extending from the B terminal of any convenient source of current such as a battery not shown over front contact 18 of track relay TRQ, lamp G, and to the terminal C of the same source of current. Hence, a green light is displayed by signal S when no train is approaching the intersection within the limits of the stretch of railway under consideration to indicate clear traffic conditions for the highway.

I will next describe the operations which take place when a train moving toward the intersection in the direction indicated by the arrow is traveling at a speed so low that the three separate timing devices 1TH, 2TH and 3TH all function. When a train enters the measuring track section O—P and shunts the track relay TRP, that relay releases and completes a heating circuit which can be traced from the B terminal of the current source over back contact 19 of relay TRP, line wire 20, front contact 21 of track relay TRQ, wire 22, back contact 23 of relay 1C, heater element 24 of terminal relay 1TH and to the C terminal of the current source. At the expiration of the operating time of relay 1TH, here assumed as 30 seconds, the contact 25 is closed and current is supplied to the winding of relay 1C over a simple circuit, and that relay is picked up. Relay 1C on picking up closes a stick circuit by which it is retained energized and which circuit includes its own front contact 27 and a normally closed contact 26 of the timing device or thermal relay 1TL. When relay 1C is picked up and its back contact 23 is opened and its front contact 28 is closed, the heating circuit is transferred from the heater element 24 of relay 1TH to the heater element 30 of the relay 2TH. To be explicit, the heating circuit now includes battery terminal B, back contact 19, line wire 20, front contact 21, wire 22, front contact 28 of relay 1C, back contact 29 of relay 2C, heater element 30 of thermal relay 2TH and to the C battery terminal. When current is thus removed from the relay 1TH, that relay quickly cools and the contact 25 is restored to its normal open position. At the expiration of the operating time of relay 2TH, here assumed as 10 seconds, its contact 31 is closed and completes a circuit for energizing the relay 2C and that relay is picked up. Relay 2C on picking up completes a stick circuit by which it is retained

energized and which circuit includes its own front contact 33 and the normally closed contact 32 of the timing device or thermal relay 2TL. When relay 2C is picked up and its back contact 29 is opened and its front contact 34 is closed, the heating circuit is transferred from the heater element 30 of relay 2TH to the heater element 67 of the relay 3TH, the circuit including back contact 38 of the relay 3C. The heater element of the relay 2TH being now without current, that relay quickly cools and contact 31 is restored to its normal open position. The relay 3TH next functions at the end of its operating time, here assumed as 10 seconds, to close its contact 35 and complete an energizing circuit for the relay 3C, and that relay is picked up. Relay 3C is then retained energized over a stick circuit including its own front contact 36 and the normally closed contact 37 of the associated timing device or thermal relay 3TL. The control relay 3C on picking up and opening its back contact 38 removes current from the heater element 67 of relay 3TH and that relay quickly cools and contact 35 is restored to its normal open position. Consequently, the three control relays 1C, 2C and 3C are successively picked up and stuck energized by successive operation of the thermal relays which constitute the timing devices of the first series when a train approaching the highway is traveling at a speed so low that it requires 50 seconds or more for it to advance through the measuring section O—P.

It is to be noted that in Fig. 1 the signal S continues to display a clear indication during the time the train is passing through the measuring section since the track relay TRQ remains energized and its front contact 18 which governs the circuit for the lamp G is closed.

When this train advances and enters the operating section P—Q, the track relay TRQ releases and opens its front contacts 18 and 21 and closes its back contact 39. The opening of the front contact 18 of relay TRQ causes the G lamp of signal S to be extinguished. The opening of the front contact 21 of relay TRQ opens the heating circuit for the timing devices of the first series, but no function is performed in this instance since the heating circuit has already been opened at the back contact 38 of relay 3C as explained above. The closing of the back contact 39 of relay TRQ completes a circuit extending from the B battery terminal over back contact 39, wire 40, winding of relay CR, wire 41, front contact 42 of relay 1C since that relay is now energized, heater element 43 of thermal relay 1TL and to the C battery terminal. The current flowing in this circuit is sufficient to pick up the relay CR as well as to heat the relay 1TL. The relay CR on picking up completes a circuit which branches from wire 40 over front contact 44 of relay CR, wire 45, front contact 46 of relay 3C since this relay is now energized, wire 47, lamp Y of signal S, and to the C battery terminal, and the yellow lamp Y is illuminated and signal S displays a warning indication. At the expiration of the operating time of the thermal relay 1TL, here assumed as 10 seconds, its contact 26 interposed in the stick circuit of relay 1C is opened and relay 1C is released. Relay 1C upon releasing transfers the heating circuit from the heater element 43 of relay 1TL to the heater element 49 of relay 2TL by switching the connection from front contact 42 to its back contact 48, and the heater element 49 of relay 2TL is supplied with current, the connection also including the front contact 50 of relay 2C. At the expiration of 10 seconds, the relay 2TL opens its contact 32 which is interposed in the stick circuit of relay 2C and relay 2C is released and transfers the heating circuit from the heater element 49 of relay 2TL to the heater element 51 of the next relay 3TL, the circuit connection now including back contact 52 of relay 2C, and front contact 53 of relay 3C as will be readily understood by an inspection of Fig. 1. At the expiration of the next 10 seconds, relay 3TL operates its contact 37 which is interposed in the stick circuit of relay 3C, and relay 3C is released. With relay 3C released, the circuit for lamp Y is opened at front contact 46 and the yellow light is extinguished, and the heating circuit which also includes the winding of relay CR is opened at the front contact 53 with the result the relay CR is released at the expiration of its slow release period. Just prior to the release of relay CR a circuit is formed from battery terminal B, back contact 39 of relay TRQ, wire 40, front contact 44 of relay CR, wire 45, back contacts 55, 56, and 68 of relay 3C, 2C and 1C, respectively, wire 6, operating windings 4 and 5 of the flasher relay FR and to the C battery terminal and relay FR is operated in the manner described hereinbefore. Then with relay CR released and its back contact 54 closed the same circuit is completed except that the back contact 54 shunts around the back contacts of the chain of relays. In both cases two branch circuits extend from wire 6, one of which includes the contact member 13 of relay FR, contact 17, right-hand lamp R of signal S and to the C battery terminal, and the other of which includes contact member 12 of relay FR, contact 14, left-hand lamp R of signal S and to the C battery terminal. It follows that as soon as the last relay of the chain is released the Y lamp of signal S is extinguished, the flasher relay FR is operated and the two R lamps of signal S are alternately flashed to display a stop signal to the highway users. Since the total operating time of the three timing devices 1TL, 2TL and 3TL is 30 seconds, it follows that during the first 30 second period subsequent to the train occupying the operating section P—Q, a yellow light is displayed by signal S, but that subsequent to such 30 second period, the signal S displays a flashing red light until the rear of the train passes to the right of the highway and vacates the section P—Q and the track relay TRQ is again energized. Since the total operating time of the three relays or timing devices 1TH, 2TH and 3TH of the first series is 50 seconds, and the total operating time of the three relays or timing devices 1TL, 2TL and 3TL of the second series is 30 seconds, a stop indication is exhibited for at least 20 seconds prior to the arrival of this train at the intersection, which train I have assumed to be moving slow enough through the measuring section to permit the three timing devices 1TH, 2TH and 3TH to function and which train will consequently consume the same interval of time in passing through the operating section, assuming, of course, there is no acceleration.

If a train approaching the highway is travelling at a speed between 60 miles per hour and the maximum speed of 90 miles per hour, it will advance through the measuring section O—P and enter the operating section P—Q in something less than 30 seconds, and hence the time measuring device 1TH will not have been heated long enough to close contact 25 and pick up the relay 1C before the track relay TRQ is shunted and the

heating circuit is opened at front contact 21. Under these circumstances the shunting of the track relay TRQ and closing its back contact 39 supplies current at once to the flasher relay FR over the back contact 54 of relay CR since relay CR is normally deenergized, and since the opening of front contact 21 of relay TRQ removes current from the timing device 1TH and stops further operation of the time measuring mechanism. Thus, the clear signal lamp G is extinguished and the stop lamps R are flashed for this train as soon as it enters the operating section. As it requires substantially 20 seconds for a train travelling at the maximum speed of 90 miles per hour to pass through the operating section, and approximately 30 seconds for a train travelling at 60 miles per hour to pass through the operating section, a stop signal is provided for a period not less than 20 seconds and not more than 30 seconds prior to the arrival of a train at the intersection when the train is travelling between 60 and 90 miles per hour.

If a train approaching the highway is travelling at a speed below 60 miles per hour and above 45 miles per hour, it consumes something between 30 seconds and 40 seconds in passing through the measuring section and the thermal relay 1TH is operated to pick up the relay 1C in the manner explained hereinbefore, but the second thermal relay 2TH has not been heated a sufficient length of time to close its contact 31 and energize the relay 2C. This time the shunting of track relay TRQ and the opening of its front contacts 18 and 21 and the closing of its back contact 39 extinguishes the green lamp G, discontinues the supply of current to the heating circuit for the thermal relays which constitute the timing devices of the first series, and supplies current to the heating circuit of the thermal relays which constitute the timing devices of the second series, current flowing in this latter circuit being also effective to energize the controlling relay CR. Relay CR on picking up and closing its front contact 44 completes a circuit for the Y lamp which circuit branches from wire 40 over front contact 44, wire 45, back contact 55 of relay 3C, back contact 56 of relay 2C, front contact 57 of relay 1C, wire 47, lamp Y and to the C battery terminal. At the expiration of 10 seconds the contact 26 of thermal relay 1TL is opened and relay 1C is released and its front contacts 42 and 57 are opened with the result that the controlling relay CR is deenergized and the Y lamp is extinguished. When relay 1C is released current is supplied over back contact 39 of relay TRQ and front contact 44 of relay CR and the back contacts of the relays of the chain, or over the back contact 54 of relay CR to flasher relay FR and in turn to the stop lamp R of signal S, the same as explained hereinbefore. That is to say for train speeds between 45 and 60 miles per hour the relay 1C is picked up and the Y lamp of signal S is illuminated for 10 seconds subsequent to the train entering the operating section after which the Y lamp is extinguished and the stop lamps R are flashed. Since at such speeds a train requires between 30 and 40 seconds to advance from the entrance of the operating section to the highway, a stop signal is displayed at least 20 seconds and not over 30 seconds prior to the arrival of the train at the intersection.

If a train approaching the highly is travelling at a speed a little less than 45 miles per hour the time consumed in passing through the measuring section is slightly over 40 seconds and both devices 1TH and 2TH are operated and both relays 1C and 2C are picked up. The shunting of track relay TRQ and the opening of its front contacts 18 and 21 and the closing of its back contact 39 in response to this train entering the operating section P—Q causes the G lamp to be extinguished, causes the supply of current to the heater elements of the first series of timing devices to be discontinued, and supplies current to the heating circuit for the second series of timing devices. A circuit for the Y lamp now branches from wire 40 over the front contact 44 of relay CR, wire 45, back contact 55 of relay 3C, front contact 63 of relay 2C and thence the same as before traced. Current supplied to the heating circuit of the devices of the second series causes the devices 1TL and 2TL to be successively operated and the two control relays 1C and 2C to be successively released in the same manner described for the slow moving train and the operation need not be repeated in detail. With release of relay 2C the controlling relay CR is left without current and releases at the end of its slow release period. Following the release of relays of the chain the lamp Y is extinguished and current is supplied to the flasher relay FR and to the stop lamps R the same as in former cases. Since operation of the devices 1TL and 2TL requires 20 seconds, a delay of 20 seconds is effected subsequent to this train entering the operating section before the signal S displays a stop indication. This train moving slightly less than 45 miles per hour consumes something over 40 seconds in advancing from the entrance of the operating section to the highway and hence a period of at least 20 seconds operation of the stop signal prior to the arrival of the train at the intersection is assured.

In the form of invention disclosed in Fig. 2, the track layout, the circuits and the apparatus are the same as in Fig. 1 except a repeater relay RP is added and the Y lamp is illuminated as soon as a train enters the measuring track section O—P. The repeater relay RP is normally energized over a front contact 58 of track relay TRP and line wire 59. The circuit for the G lamp includes a front contact 60 of relay RP as well as the front contact 18 of track relay TRQ. The Y lamp is provided with two circuits, a first one of which includes the B battery terminal, front contact 18 of relay TRQ, back contact 61 of relay RP, wire 62, lamp Y, and to the C battery terminal; and the second one of which may be traced from the B battery terminal over back contact 39 of relay TR2, wire 40, front contact 44 of relay CR when that relay is energized, wire 45, front contact 46 of relay 3C to wire 47, or back contact 55 of relay 3C and front contact 63 of relay 2C to wire 47, or back contacts 55 and 56 of relays 3C and 2C, respectively, and front contact 57 of relay 1C to wire 47, thence over a second back contact 64 of relay TRQ, wires 65 and 62, lamp Y and to the C battery terminal.

In this form of my invention, the repeater relay RP is released immediately upon a train entering the measuring section O—P and shunting the track relay TRP. Releasing of relay RP extinguishes the G lamp of signal S and illuminates the Y lamp by virtue of the front contact 60 of relay RP being opened and the back contact 61 being closed. Successive operation of the devices 1TH, 2TH and 3TH to pick up the chain of relays 1C, 2C and 3C, while the train is advancing through the measuring section is accomplished in exactly the same manner explained in detail in Fig. 1 and it is thought to be unnecessary to

repeat the description except to point out that the heating circuits for the devices 1TH, 2TH and 3TH are supplied with current over a back contact 66 of relay RP and front contact 21 of track relay TRQ, whereas in Fig. 1 these same circuits receive current over back contact 19 of track relay TRP and front contact 21 of track relay TRQ. When a train enters the operating section P—Q of Fig. 2, operation of the first series of timing devices 1TH, 2TH and 3TH is stopped and operation of the second series of devices 1TL, 2TL and 3TL is initiated the same as described for Fig. 1. Although the first circuit for the Y lamp is opened at the front contact 18 of relay TRQ when a train enters the operating section, the lamp Y is supplied with current and remains illuminated by virtue of the second circuit including the front contact 44 of relay CR and the contacts controlled by the chain of relays 1C, 2C and 3C until the relays of the chain have all been released. When the relays of the chain have all been released, the Y lamp is then extinguished, the controlling relay CR is deenergized and current is supplied to the flasher relay FR and to the stop lamp R of signal S the same as previously described.

One objection that has been raised to former schemes for highway crossing signals operating a substantially uniform time for all values of speeds has been that after a train advanced through a measuring section and established a timing mechanism to operate the signal according to the speed, the train might accelerate and cut down the operating time of the highway signal. With apparatus constructed in accordance with my present invention, a warning indication is displayed when the train has reached a fixed distance from the intersection (entrance of operating section in Fig. 1 and entrance of measuring section in Fig. 2) and continues to show until the stop indication is established. Hence, highway users are not without warning of an approaching train notwithstanding the display of a danger or stop signal may be a little less than the desired fixed time due to acceleration of the train speed.

Although I have herein shown and described only two forms of apparatus embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In combination, a stretch of railway track intersected by a highway, a highway signal capable of displaying three indications located adjacent the intersection, a time measuring mechanism, means effective when no train is approaching the highway for causing the signal to display a first one of said indications, means controlled by a train approaching the highway upon reaching a fixed point for causing the signal to display a second one of said indications, means controlled by a train approaching the highway while traveling a fixed distance for operating said mechanism to determine the speed of the train, and means controlled by said mechanism for causing the signal to display a third one of said indications in accordance with the speed of the train.

2. In combination, a stretch of railway track intersected by a highway, a highway signal capable of displaying a green light and a yellow light as well as a red light and said signal located adjacent the intersection, a time measuring mechanism, means effective when no train is approaching the highway for causing the signal to display the green light, means controlled by a train approaching the highway upon reaching a fixed point for causing the signal to display the yellow light, means controlled by a train approaching the highway while traveling a fixed distance for operating said mechanism to determine the speed of the train, and means controlled by said mechanism for causing said signal to display the red light in accordance with the speed of the train.

3. In combination, a stretch of railway track intersected by a highway, a highway signal capable of displaying three indications located adjacent the intersection, a time measuring mechanism, means effective when no train is approaching the highway for causing the signal to display a first one of said indications, means controlled by a train approaching the highway while traveling a fixed distance for operating said mechanism to determine the speed of the train, means controlled jointly by a train approaching the highway and by said mechanism for causing the signal to display a second one of said indications when the train reaches a fixed point, and means controlled by said mechanism for causing the signal to display a third one of said indications in accordance with the speed of the train.

4. In combination, a stretch of railway track intersected by a highway, a highway signal capable of displaying three indications located adjacent the intersection, a slow acting mechanism having a normal and an extreme position and adaptable of being operated between said two positions in response to current supplied thereto, means effective when no train is approaching the highway for causing the signal to display a first one of said indications, means controlled by a train approaching a fixed point in the rear of the highway to supply current to the mechanism for causing said mechanism to be operated away from said normal position toward said extreme position, other means controlled by the train upon reaching said fixed point for causing said mechanism to be operated from the point to which it had advanced back to said normal position, means controlled in part by said mechanism when operated away from its normal position for causing the signal to display a second one of said indications, and other means controlled by said mechanism when operated back to its normal position for causing the signal to display a third one of said indications.

5. In combination, a stretch of railway track intersected by a highway, a highway signal comprising a green light and a yellow light as well as a red light located adjacent the intersection, a speed measuring mechanism, means effective when no train is approaching the highway for causing the signal to display the green light, means controlled by a train approaching the highway for operating said mechanism to determine the speed of the train, means controlled by a train upon reaching a fixed point in the rear of the highway for causing the signal to display the yellow light, and means controlled by said mechanism for causing the signal to display the red light an interval within a given variation prior to arrival of the train at the intersection regardless of the speed of the train.

6. In combination, a stretch of railway track intersected by a highway, a highway signal comprising a green light and a yellow light as well

as a red light located adjacent the intersection, a time measuring mechanism, means effective when no train is approaching the intersection for causing the signal to display the green light, means controlled by a train in traveling a fixed distance to the rear of the highway for operating said mechanism to determine the speed of the train, means controlled jointly by the train and by said mechanism for extinguishing the green light and for causing the signal to display the red light an interval within a given variation prior to arrival of the train at the intersection regardless of the speed of the train, and means controlled by said mechanism for causing the signal to display the yellow light the interval between extinguishing the green light and the display of the red light.

7. In combination, a stretch of railway track intersected by a highway, a highway signal comprising a green light and a yellow light as well as a red light located adjacent the intersection, a time measuring mechanism, means effective when no train is approaching the intersection for causing the signal to display the green light, means controlled by a train while traveling a fixed distance in approaching a fixed point to the rear of the highway for operating said mechanism to determine the speed of the train, means controlled by a train upon reaching said fixed point effective to extinguish the green light and for later causing the signal to display the red light, means controlled by said mechanism for delaying the display of the red light in inverse proportion to the speed of the train, and means controlled by said mechanism for causing the signal to display the yellow light during such delay.

8. In combination, a stretch of railway track formed into a measuring and an operating section, the latter of which is intersected by a highway, a highway signal capable of displaying three indications located adjacent the intersection, a track circuit including a track relay for each of said sections, a chain of relays, means set into operation by the track relay of the measuring section for energizing a variable number of the relays of the chain depending on the time such measuring section is occupied prior to the entry of the train into the operating section, means set into operation by the track relay of the operating section to effect release of the energized relays of the chain one at a time in response to the entry of the train into the operating section, means controlled by the track relay of the operating section effective to cause the signal to display a first one of said indications when said section is unoccupied, means controlled by said relay chain effective with the operating section occupied to cause the signal to display a second one of said indications when any one of the relays of the chain is energized, and other means controlled by said relay chain effective with the operating section occupied to cause the signal to display a third one of said indications when all of the relays of the chain have been released.

9. In combination, a stretch of railway track intersected by a highway, a highway signal capable of displaying three indications located adjacent the intersection, a speed measuring mechanism including a first and a second time measuring device, means effective when no train is approaching the highway for causing the signal to display a first one of said indications, means controlled by a train traveling a fixed distance in approaching a fixed point to the rear of the highway for operating said first time measuring device, means controlled by a train upon reaching said fixed point for retaining said first device at the point to which it has advanced and for starting operation of said second device, means controlled by said first device when operated for causing the signal to display a second one of said indications, and means controlled by the second device when it has advanced to a point corresponding to the position of said first device for causing the signal to display a third one of said indications.

10. In combination, a stretch of railway track intersected by a highway, a highway signal comprising a green light and a yellow light as well as a red light located adjacent the intersection, a speed measuring mechanism, means effective when no train is approaching the highway for causing the signal to display the green light, means controlled by a train approaching a fixed point to the rear of the highway for operating said mechanism to determine the speed of the train, operating means controlled by the train upon reaching said fixed point for causing the signal to display the red light, means controlled by said mechanism for delaying said operating means in governing the signal for an interval inversely proportional to the speed of the train, and means controlled by said mechanism for causing the signal to display the yellow light during such delay interval.

11. In combination, a stretch of railway track intersected by a highway; a highway signal capable of displaying a clear, a warning and a stop indication and said signal located adjacent the intersection; a mechanism including a control relay as well as a first and a second time measuring device, said devices each adaptable when supplied with current of operating a contact member in a predetermined time interval, said control relay provided with an energizing circuit including a normally open contact of the first device and a stick circuit including a normally closed contact of the second device, a normally deenergized controlling relay, circuit means controlled by a train while traveling a fixed distance in approaching a fixed point to the rear of the highway for supplying current to said first device to pick up said control relay when the train is traveling less than a certain speed, other circuit means controlled by a train upon reaching said fixed point for supplying current to said second device, said other circuit means including the winding of said controlling relay and a front contact of said control relay, means effective when no train is approaching the highway for causing the signal to display the clear indication, means including a front contact of the controlling relay for causing the signal to display the warning indication, and means including a back contact of the controlling relay for causing the signal to display the stop indication.

12. In combination, a stretch of railway track intersected by a highway, a highway crossing signal located at the intersection and capable of displaying a stop indication and a warning indication, a speed measuring mechanism, means controlled by a train approaching a fixed point to the rear of the highway for operating said mechanism to determine the speed of the train, operating means controlled by the train upon reaching said fixed point to cause the signal to display the warning indication, and means controlled by said mechanism for extinguishing the warning indication and initiating the display of the stop

indication of the signal an interval after the train reaches said fixed point and which interval is inversely proportional to the speed of the train.

13. In combination, a stretch of railway track intersected by a highway, a highway crossing signal located at the intersection and including a red light and a yellow light, a speed measuring mechanism, means controlled by a train approaching a fixed point to the rear of the highway for operating said mechanism to determine the speed of the train, operating means controlled by the train upon reaching said fixed point for causing the signal to display the red light unless delayed by said speed measuring mechanism, means controlled by said mechanism for delaying said operating means in displaying the red light for an interval which is inversely proportional to the speed of the train, and means controlled by said mechanism for causing the signal to display the yellow light during such delay interval.

14. In combination, a stretch of railway track intersected by a highway, a highway crossing signal located at the intersection and capable of displaying a stop indication and a prepare to stop indication, a speed measuring mechanism, means controlled by a train approaching a fixed point to the rear of the highway for operating said mechanism to determine the speed of the train, operating means controlled by said mechanism to initiate the display of the stop indication of said signal an interval after the train reaches said fixed point and which interval is inversely proportional to the speed of the train, other operating means controlled by said mechanism to cause the signal to display the prepare to stop indication from the time the train reaches said fixed point until the expiration of said interval, and means effective when no train is approaching the highway to suppress the display of the stop and the prepare to stop indications by said signal.

15. In combination, a stretch of railway formed into a measuring and an operating track section, the latter of which is intersected by a highway, a highway crossing signal located at the intersection and capable of displaying a stop indication and a warning indication, a track circuit for each section including a track relay, a time measuring means, means set into operation by the track relay of the measuring section for actuating the time measuring means to determine the time the measuring section is occupied prior to the entry of a train into the operating section, means controlled by the track relay of the operating section to reverse the action of the time measuring means when the train enters the operating section, operating means controlled by the track relay of the measuring section to cause the signal to display the warning indication in response to the train entering the measuring section, and other operating means controlled by the time measuring means to cause the signal to display the stop indication a time interval after the train enters the operating section and which interval is proportional to the time the train occupied the measuring section.

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