My invention relates to highway crossing protection apparatus, that is, to apparatus protecting the intersection of a stretch of railway track with a highway.

An object of my invention is the provision of novel and improved means controlled by railway and highway traffic for governing the operation of highway crossing gates and highway crossing signals.

Another object of my invention is the provision of novel and improved means for operating highway crossing gate arms.

Other objects and advantages of my invention will appear as the specification progresses.

I shall describe one form of apparatus embodying my invention, and shall then point out the novel features thereof in claims.

In the accompanying drawings, Fig. 1 is a diagrammatic view showing a preferred form of apparatus embodying my invention. Fig. 2 is a vertical sectional view showing in detail and on an enlarged scale a preferred form of gate operating apparatus which may be employed in conjunction with the apparatus of Fig. 1, and also embodying my invention. Fig. 3 is a vertical sectional view, taken at right angles to Fig. 2, showing a portion of the apparatus of Fig. 2.

Referring to Fig. 1, the reference character Y designates one track of a double track railway, and the reference character Z designates the other track of the railway, the tracks Y and Z being intersected at grade by a highway H. Railway traffic along each track normally operates in the direction indicated by the associated arrows shown in Fig. 1. As shown, the track rails 1 and 1a of track Y are divided by means of the usual insulating joint 2 into a track section 3 extending from highway H in the direction of approaching traffic, and track rails 1 and 1a of track Z are similarly divided by means of the joints 2 into a track section F—G extending from the highway in the direction of approaching traffic. Sections D—E and F—G are provided with track circuits comprising in each instance a suitable source of current, such as track battery TB, connected across the track rails at one end of the section, and a track relay designated by the reference character TRY or TRZ, respectively, connected across the rails at the other end of the section. It is to be understood, of course, that the scope of my invention embraces the control of highway crossing protection apparatus by traffic operating over single or multiple track railways as established by any of the well-known track circuit control systems, and is not limited to the specific control established by relays TRY and TRZ as herein shown as an illustration.

The highway H is adapted to be traversed in either direction by highway traffic. In accordance with the usual custom, I shall refer to the normal direction of traffic operating over highway H as being traffic approaching the intersection in the right-hand lane or lanes of the highway, and the reverse direction of traffic operating over highway H as being traffic approaching the intersection in the left-hand lane or lanes. Located at selected points on either side of the intersection is a pair of highway crossing gates. Each pair of crossing gates comprises an entrance gate, designated by the reference character NG plus a suitably distinguishing suffix, and an exit gate, designated by the reference character XG plus a suffix corresponding to the suffix employed in the reference character of its associated entrance gate. The gates NG and XG are arranged so as to permit traffic operating over highway H to cross the intersection if traffic conditions on tracks Y and Z warrant, and at other times to prevent highway traffic from crossing the intersection. The manner in which gates NG and XG are controlled will be made clear presently, but at this time it should be pointed out that gates NG are of such length as to at times effect the obstruction of the right-hand lanes of highway H for preventing traffic operating in the normal direction of the highway H from crossing the intersection, and the gates XG are of such length as to at times effect the obstruction of the left-hand lanes of highway H for preventing traffic operating thereover in the reverse traffic direction from crossing the intersection. The gate operating mechanism for highway crossing gates NG and XG may take any suitable form, but a preferred form is that shown in Figs. 2 and 3.

Referring now to Figs. 2 and 3, a highway crossing gate operating mechanism constructed in accordance with my invention as shown comprises a supporting pedestal P, preferably firmly fastened to a base K, and serving to support an operating head 3 having a removable cover 3a. The head 3 is shown mounted on the ball bearings 4 for permitting the head to rotate in a horizontal plane about the center of pedestal P, and preferably the head is biased to a normal operating position by any suitable means such as, for example, the biasing device shown in United States Letters Patent 1,893,824 granted January 10, 1933 to William C. McWhirter for Automatic crossing.

UNIVERSAL STATES PATENT OFFICE

2,203,914

HIGHWAY CROSSING PROTECTION APPARATUS

John W. Logan, Jr., Forest Hills, Pa., assignor to The Union Switch & Signal Company, Swis
vale, Pa., a corporation of Pennsylvania

Application March 17, 1939, Serial No. 365,485

7 Claims. (Cl. 246—130)
gates. A rotatable shaft 5 journaled in bearings 6 located in the sidewalls of head 3 is adapted to be operatively connected with a highway crossing gate arm 7 by means of a yoke member 8 splined to shaft 5 and having gate arm 7 fastened thereto. A pinion segment 9 is keyed to shaft 5, and intermeshes with a rack gear 10 formed integrally with, or fastened to, a connecting member 11. The connecting member 11 operates within a bearing recess 12 provided in a bearing support 13, and is connected at one end with a piston 14, and at the other end with a piston 15. The interconnecting pistons 14 and 15, forming a portion of a fluid operable means for rotating the shaft 5, operate within cylinders 16 and 17, respectively. The lower walls (see Fig. 2) of cylinders 16 and 17 are extended to form a support for the bearing support 13, and also to provide a partition in head 3 adapted to establish a reservoir space. A suitable form of operating fluid may be introduced into the reservoir space through a threaded tap hole 18 provided at the extreme top portion of cover 20, the tap hole normally being closed as shown by a plug 19 threading therein. Preferably, the level of the operating fluid is maintained above the rotatable shaft 5, so that the shaft bearings 6, the rack and pinion gears 10 and 9, respectively, and the pistons 14 and 15 are immersed in such fluid. The bearing support 13 is provided with openings 20 connected with a pipe 21 for connecting the fluid reservoir with the pressure producing means.

The pressure producing means, as shown, comprises a rotary gear pump 22 operatively connected with a reversible electric motor 23. The motor and pump are suitably supported by members 24 attached to the head 3, and thus are free to rotate with the head. The pump 22 is suitably connected with cylinders 16 and 17 by means of pipes 25, 26, 27 and 28, and by means of a pressure responsive device 29. The device comprises a cylinder 30, having operating therein pistons 31 and 32 interconnected by a piston rod 33. The pistons are biased at an extreme left-hand position, as shown in Fig. 1, or to an extreme right-hand position, which is the position the reverse of that shown in Fig. 1, by means of a toggle member 34 engaging a cam portion 35 provided on the rod 33. The parts are preferably so proportioned that when toggle member 34 is actuated by a compression spring 36 into engagement with rod 33, the bias exerted by spring 36 upon member 34 is sufficient to restrain pistons 31 and 32 against free movement, the pistons moving only in the event that an external pressure is exerted upon a piston sufficient to overcome the biasing force of member 34 against cam portion 35 of member 33. Each end of cylinder 30 is provided with a spring-biased valve. As shown, valve 37 provided for the left-hand end of cylinder 30 (as viewed in Fig. 2) is provided with a valve member 38 biased by means of a spring 39 into engagement with a valve surface 40 provided for cylinder 30, valve member 39 being provided with a stem portion 41 engageable by piston 31 for forcing the valve member open against its spring bias. Valve 42 provided for the right-hand end of cylinder 30 is similarly arranged with a valve member 43, having a stem portion 44 engageable by piston 32, and biased by a spring 45 into engagement with valve surface 46 of cylinder 30. The pipe 21 connects the reservoir space provided in head 3 with the central portion of cylinder 30, and the cylinder is provided with leak grooves 30a and 30b disposed to by-pass piston 31 or 32 respectively, when either piston is positioned in its extreme end position of the cylinder, the pipe 21 and the leak groove 30a or 30b connecting the fluid in the reservoir with pump 22, thereby establishing a supply of operating fluid for the pump. Pressure relief valves 47 and 48 are so connected across pipes 27 and 28 which are connected with the left-hand and right-hand orifices of pump 22, respectively, as to by-pass the operating fluid across these pipes in the event that the pressure in pipe 27 or 28 rises above a predetermined value by valve 47 by-passing any extreme pressure in pipe 27 and valve 48 by-passing any extreme pressure in pipe 28. A manually operable by-pass valve 49 is connected across the pipes 25 and 26 and is effective when operated to by-pass the pressure responsive device 29, to thereby permit a counterweight, which is usually provided for the gate arm 1, to control the position of the arm by gravity.

In explaining the operation of the highway crossing gate operating mechanism just described, it shall be assumed that the gate arm 7 is in its normal position of the apparatus. In this condition of the apparatus, gate arm 7 is raised to a position substantially 70° above the horizontal so that it assumes a non-obstructing position with reference to the highway, with the result that highway traffic is permitted approach and cross the intersection. In the normal position of the gate operating apparatus, as illustrated in Figs. 2 and 3, the pressure responsive device 29 is operated to its left-hand position, with the result that pistons 31 and 32, open, valve 42 is closed by virtue of its spring bias, and pump 22 is connected through pipe 27, the leak groove 30a of cylinder 30 provided around piston 31, and pipe 21 with the operating fluid stored in the reservoir space in head 3.

In the event motor 23 is controlled to actuate pump 22 to lower the gate arm, the pump is actuated to force the operating fluid through pipe 27, and to withdraw the fluid from pipe 28. This action of the pump creates a pressure differential within device 29, with the result that piston 31 forces connecting rod 33 past biasing member 34, thereby operating pistons 31 and 32 to their right-hand positions. In this position of device 29, valve 37 is closed by virtue of its spring bias, valve 42 is opened by virtue of piston 32 engaging valve stem 44, and pump 22 is connected through pipe 28, the leak groove 30b provided for cylinder 30 around piston 32 of device 29, and pipe 21 with the fluid reservoir in head 3.

The opening of valve 42 connects the fluid within cylinder 17 with pipe 28, which now functions as the pump inake pipe. Further actuation of pump 22 forces valve 37 open, by virtue of the fact that the pressure in pipe 27 exceeds the spring bias of the valve, and the fluid is forced through pipe 25 into cylinder 16, thereby actuating piston 14 to the right, as viewed in Fig. 2. The actuation of piston 14 forces connecting rod 13 past biasing member 10 to actuate piston 15, thereby forcing the fluid from cylinder 17, and the actuation of member 10 is transmitted through rack gear 11 to piston segment 9, thereby rotating shaft 5 and lowering gate arm 7. When pistons 14 and 15 have reached their extreme right-hand position, that is, the positions the reverse of those shown in Fig. 2, the gate arm is operated to its obstructing or horizontal position wherein the highway is obstructed with the result that highway traffic is prevented from approaching the intersection.
When the gate arm reaches its full obstructing position, the operation of motor 23 will usually be terminated by any suitable means such as, for example, the operation of a circuit controller J which is preferably provided, in a manner to be pointed out in detail hereinafter in connection with controllers NJ1 and XJ1, with fixed and movable contact members, the latter of which being controlled by the position of the associated gate arm for selectively closing control contacts in accordance with the position of the gate arm. The operation of the apparatus in restoring the gate arm to its normal position is the reverse of the operation just described. It is believed that this latter operation will be apparent from the foregoing description together with an inspection of the drawings, and further detailed description is deemed unnecessary, except to point out that motor 23 is operated to actuate pump 22 so that fluid is forced through pipe 28, and is withdrawn from pipe 27, and that the pressure differential established within device D operates pistons 31 and 32 to their left-hand positions, as illustrated in Fig. 2.

It should be pointed out that device D functions to control the flow of the operating fluid from operating cylinders 16 and 17 to pump 22, and also serves to lock the gate arm in its last operated position. That is to say, when the gate arm is operated to its normal or non-obstructing position, for example, device D is also operated to its normal position. In this position of the device, valve 42 is held closed by virtue of the spring bias, so that the fluid is prevented from returning from cylinder 17 to pump 22. Valve 37 is held open to establish a fluid path from cylinder 16 to the pump, and the leak groove 30a provided for cylinder 30 on the right hand side of device D connects the fluid path to the pump. It can be seen, therefore, that device D locks the gate arm in its last operated position since the device functions as a non-return check valve for the fluid system, and that device D also serves to connect the fluid reservoir with pump 22, whereby a positive head is always impressed upon the pump and thereby insuring its proper operation. It should further be noted that inasmuch as the shaft bearings 8, gears 9 and 10, and pistons 14 and 15 are immersed in the operating fluid, the elements named are lubricated at all times with the result that friction between the moving parts may be greatly reduced, thereby resulting in a more effective operating mechanism.

One advantage of apparatus embodying my invention is the provision of novel and improved means for operating highway crossing gate arms. Referring once more to Fig. 1, the control apparatus and control circuits therefor, for only a pair of highway crossing gates NG1 and XG1 are shown for the sake of clearness and simplicity, it being understood that in actual practice, entrance gate NG1 will be controlled by apparatus substantially duplicating the apparatus shown in Fig. 1 and referred to hereinafter as controlling entrance gate NG1, and exit gate XG2 will be controlled similarly by control apparatus substantially duplicating the apparatus shown in Fig. 1 and referred to hereinafter as controlling exit gate XG2. In like manner, it should be understood that the control apparatus provided for gate NG2 preferably will be controlled in a manner substantially similar to the manner, hereinafter pointed out, that the control apparatus for gate NG1 is controlled.

The reference character NJ1 designates a circuit controller operatively associated with entrance gate NG1. As shown, circuit controller NJ1 comprises movable contact members 53, 54, 55 and 56, operatively connected in accordance with the usual practice with its associated crossing gate arm. Each movable contact member engages an associated fixed contact member 57, 58, 59 or 60, respectively, during preselected angular movement of the gate arm, contacts 53—57, 54—58, 55—59 and 56—60 being closed respectively at the 0°-65°, 5°-70°, 60°-70° and 0°-20° positions of the gate arm, the 0° position of the gate arm being its horizontal or obstructing position, and the vertical or clear position being substantially 70° angular movement with respect to the horizontal or zero position. The reference character XJ1 designates a circuit controller controlled by the gate arm of gate XG1, and provided with contact 53—57 closed at the 0°-65° position of the gate arm, contact 54—58 closed at the 5°-70° position of the gate arm, and contact 55—59 closed at the 60°-70° position of the gate arm.

The gates NG1 and XG1 are provided with suitable operating means preferably of the type hereinbefore described, each including a reversible electric motor 23 having a field winding 61 and an armature winding 62, and operatively connected with the associated gate arm to operate it to its obstructing and non-obstructing positions. Also, each gate arm is provided with suitable signaling devices, here shown in the form of electric lamps designated by the reference characters 63. The lamps 63 are adapted to be mounted on each highway crossing gate arm so as to be visible to highway traffic approaching the intersection in the traffic lanes that gate arm is adapted to govern, and preferably each lamp 63 is adapted to display a red or "stop" indication. While two lamps 63 are shown provided for each gate arm, it is to be understood that any desired number of lamps may be provided for each arm. As is readily apparent from an inspection of the drawings, the lamps 63 for each gate arm are energized over a circuit passing from one terminal B of a suitable source of current, such as a battery not shown, through contact 53—57 (closed in the 0°-65° position of its associated arm) of circuit controller NJ1 or XJ1 and the filaments of lamps 63 of gate NG1 or XG1, respectively, to the other terminal C of the current source.

The reference characters 64 designate suitable sources of light for actuating light responsive devices, to be referred to hereinafter. As illustrated in Fig. 1, the sources 64 may be electric lamps, and preferably each lamp is located within a crossing gate house. The lamps 64 are energized by virtue of a circuit passing from terminal B through the filaments of lamps 64 and contact 56—60 of circuit controller NJ1 to terminal C. It should be noted, however, that in actual practice a similar contact provided for the entrance gate NG2 will cooperate with contact 56—60 of circuit controller NJ1 for controlling lamps 64, the contact for gate XG2 being preferably interposed in the circuit connection of lamps 64 with terminal B.

The reference characters 65a and 65b designate light responsive devices governed by the
light sources S4 and which control, in a manner to be pointed out hereinafter the operation of exit gates XG1 and XG2. Each device 6Sb or 65b controls a relay LR1 or LR2, respectively, in a manner such that its associated relay is energized only when the device is actuated by light rays emitted from its associated source of light. Preferably each device 6Sb or 65b is located with the crossing gate housing disposed diagonally opposite the intersection from its controlling source of light.

The reference character SS designates a three aspect highway crossing signal capable of displaying, in accordance with the usual custom, a red or “stop” indication, a yellow or “caution” indication, and a green or “proceed” indication. It is understood, of course, that while only one signal SS is shown located adjacent the intersection and near gate NG1 for governing traffic operating in one direction over highway H, a similar signal will in practice be installed adjacent the intersection and preferably near gate NG2 for governing traffic operating in the other direction over highway H. These three-indication crossing signals may be of any suitable type, and each preferably comprises at least two indication units provided with lamps which may be steadily illuminated or intermittently flashed. The indication units that may be employed in signal SS is shown in United States Patent Reissue No. 14,940 granted August 31, 1926 to E. J. Blake. Signal SS as herein shown comprises two signal units each of which is provided with an indication lamp 66, and a signal mechanism diagrammatically illustrated. It is deemed sufficient for the present disclosure to point out that whenever the signal mechanism of a unit is deenergized, that unit displays its “stop” indication, when the mechanism is energized by virtue of current of one polarity that unit displays its “caution” indication, and when the mechanism is energized by current of the other polarity that unit displays its “proceed” indication, provided that in each instance the lamp of the signal unit is energized.

The reference character SX designates a highway crossing signal, preferably capable of displaying a yellow or “caution” indication, and located along highway H in the rear of entrance gate NG1. Signal SX as shown is provided with an electric lamp 67 which is adapted at times to be illuminated to cause signal SX to display a preliminary warning indication to highway users. It is understood, of course, that a similar signal will in practice be located along highway H in the rear of entrance gate NG2.

The reference character TPR1 designates a repeater relay for track relays TRY and TRZ. Relay TPR1 is energized over a circuit which may be traced from terminal B through front contact 66 of relay TRY, front contact 69 of relay TRZ, and the winding of relay TPR1 to terminal C. The reference character TPR2 designates a time element device, here shown as a slow releasing relay which is energized over a simple circuit governed by front contact 70 of relay TPR1 and including a source of current and the winding of relay TPR2. The reference character TPR3 designates a relay energized over a circuit passing from terminal B through contacts 55–59 of each gate circuit controller, front contact 71 of relay TPR2, and the winding of relay TPR3 to terminal C, the circuit for relay TPR3 as shown including only contacts 55–59 of controllers NJ1 and XJ1, but it is understood that in actual practice similar circuit controller contacts provided for gates NG2 and XG2 will be serially included in this circuit.

The reference character R1 designates a gate control relay for gate NG1, the gate control circuit which may be traced from terminal B through front contact 72 of relay TRZ, front contact 73 of relay TRY, and the winding of relay R1 to terminal C. The reference character R4 designates a gate control relay for gate XG1, and preferably having slow releasing characteristics. Relay R2 is provided with a pick-up circuit passing from terminal B through front contact 74 of relay TRZ, front contact 75 of relay TRY, and the winding of relay R2 to terminal C. It is to be understood, of course, that in actual practice gate control relays will be provided for gate NG2 and the relay for gate NG2 being controlled by track relays TRY and TRZ in multiple with gate control relay R4, and the control of the gate control relay for gate XG2 being in multiple with gate control relay R2. Relay R3 designates a flasher relay for at times controlling the lamps of the three-indication signals to a flashing illuminated condition and at other times controlling such lamps to a steady illuminated condition. Relay NF may be of any suitable form, but a preferred form is that shown in United States Letters Patent Reissue No. 17,952 issued on April 2, 1929 to C. S. Snively and W. B. Wells for Electrical relays. Relay NF comprises in its essential elements two windings 79a and 79b and a pivoted armature 80 carrying insulated contact members 81, 82 and 83. When windings 79a and 79b are demagnetized, armature 80 is biased to a mid position wherein flexible contact member 81 engages a fixed contact 84 to apply a shunt across winding 79a. In this condition of the apparatus a single energized, contact member 82 engages both contacts 83 and 85, and contact member 83 engages both contacts 87 and 88. When an energizing electromagnetic force is applied across the windings 79a and 79b in a manner to later appear, winding 79a is energized to attract armature 80, thereby swinging it in a clockwise direction as viewed in Fig. 1, with the result that contact member 81 breaks engagement with contact 84 and engages fixed contact 89, thereby removing the shunt around winding 79b and applying a shunt around winding 79a. In this clockwise position of armature 80, contact member 82 engages only contact 88 and contact member 83 engages only contact 85. The energization of winding 79b attracts armature 80, with the result that the armature swivels in the opposite direction (thereby opening contacts 81–89, 82–86 and 83–88) to a position wherein contact member 82 engages only contact 85, contact member 83 engages only contact 87, and contact member 81 reengages contact 84 to reapply the shunt across winding 79a. This cycle of operation is repeated as long as the circuit for relay NF is closed, the period of oscillation of armature 80 being determined by the number of turns employed in windings 79a and 79b, these windings being provided with suitable taps for cutting out a portion of the operating turns for each winding.
parts of relay NF are preferably so proportioned that when the full number of coil turns of windings 19n and 19r are energized, the cycle of operation for relay NF is completed substantially every two seconds, or thirty times a minute, but that when a suitable portion of the windings 19n and 19r is cut out, the cycle of operation is completed substantially in operating cycle 19, or course, the proportioning of the parts of relay NF is not limited to the figure set forth above as an illustration, but may take such values best suited for the particular conditions wherein such apparatus is installed. As will appear more clearly from the drawings and descriptions hereinafter set forth, the partial number of turns of windings 19n and 19r is determined according as relay TPR3 is respectively deenergized or energized.

In the normal condition of the apparatus, as shown in Fig. 1, the gates TRY and TRZ, relays TPR1, TPR2 and TPR3, and all the gate operating relays are energized. Flasher relay NF and relays LR1 and LR2 are deenergized. Signal SX is deenergized, and each unit U1 and U2 of signal SS displays a steady "proceed" indication.

The circuit whereby signal SS is conditioned to display its "caution" indications, and the filament of lamp 56 of signal SX is energized when the gate arm is operated to its 60° position to close contact 52 of circuit controller NJ1, and when the gate arm is operated to its 60° position contact 58 of circuit controller NJ1 is opened, thereby opening the previously traced circuit for relay TPR3. If 5 should further be noted that when the gate arm of gate NG1 is operated to its 20° position, the light sources 54 are energized over their previously traced circuit including contact 56 of circuit controlled NJ1. The operation of gate NG1 is terminated when contact 54—58 of circuit controller NJ1 opens at the 5° position of its associated gate arm, the arm being operated by gravity to its full-down position.

The releasing of relay TPR1 opens front contacts 70, 102 and 103, and closes back contacts 85 and 99. The opening of front contact 70 of relay TPR1 opens the previously traced circuit for relay TPR2, while the opening of front contacts 102 and 103 opens the previously traced "proceed" circuit for each unit of signal SS. The closing of back contacts 85 and 99 of relay TPR1 completes a circuit whereby signal SS is conditioned to display its "caution" indications, since the polarity of current now supplied to the units of signal SS over the reverse of the current polarity supplied thereto over front contacts 102 and 103 of relay TPR1, as can readily be seen from an inspection of the drawing. The closing of back contact 93 of relay TPR1 completes a simple circuit including that contact, the current source, and the filament of lamp 56 of signal SX so that signal SX displays its warning indication. Back contact 93 of relay TPR1 also completes a circuit from terminal B through that contact, then through contact 82—85 of relay NF1, to the filament of lamp 66 of unit U2 of signal SS. Also in the normal condition of the apparatus, the gate arm of each gate is operated to its vertical, non-obstructing position.

In describing the operation of the apparatus of Fig. 1, I shall assume that an eastbound train, that is, a train operating on track Y from left to right as viewed in the drawing, enters track section D-E in approaching the intersection, and at the result that relay TRY releases. The releasing of relay TRY opens front contacts 75, 73 and 69 interposed respectively in the pick-up circuits for the gate operating relays controlling exit gates NG1 and NG2, in the energizing circuits for the gate operating relays controlling entrance gates NG1 and NG2, and in the energizing circuit for repeater relay TPR1, with the result that the apparatus shown in the drawing, relays R1 and TPR1 are released and relay R2 is held energized by virtue of its previously traced circuit. The releasing of relay R1 completes the "proceed" circuit for the mechanism of gate NG1, one circuit of which may be traced from terminal B through contact 54—58 of circuit controller NJ1, back contact 50 of relay R1, and the armature winding 62 of motor 23 of gate NG1 to terminal C, the other circuit of which may be traced from terminal B through contact 54—58 of circuit controller NJ1, back contact 91 of relay R1, field winding 61, and back contact 92 of relay R4 to terminal C. The relative polarity of the current in windings 61 and 62 is now such that the operating means for gate NG1 energizes its gate arm to its obstructing position. It should be noted that lamps 63 of gate NG1 are energized when the gate arm of gate NG1 is operated to its 60° position to close contact 55—57 of circuit controller NJ1, and that when the gate arm is operated to its 60° position contact 58—59 of circuit controller NJ1 is opened, thereby opening the previously traced circuit for relay TPR3. If 5 should further be noted that when the gate arm of gate NG4 is operated to its 20° position, the light sources 64 are energized over their previously traced circuit including contact 60—68 of circuit controlled NJ1. The operation of gate NG1 is terminated when contact 54—58 of circuit controller NJ1 opens at the 5° position of its associated gate arm, the arm being operated by gravity to its full-down position.
TPR1, contact 81—84 of relay NF, full winding 79b of relay NF, back contact 180 of relay TPR3 and back contact 99 of relay TPR1 to terminal C, and the circuit for winding 19m passing from terminal B through back contact 99 of relay TPR1, back contact 184 of relay TPR2, full winding 81—84 of relay NF to terminal C. It should be noted that in the event that the gate arm of gate NG1 operates to its 60° position prior to relay TPR2 releasing, the circuit for relay TPR2 is opened with the result that relay TPR3 is released to control signal SS to display its “stop” indications. It follows that signal SS is controlled to display its “stop” indications when the gate arm of gate NG1 is operated to a predetermined position, or at the expiration of the delay period for relay TPR2.

As was stated herebefore, the operation of the gate arm of gate NG1 to its 30° position completes the circuit for light sources 64. In the event that the intersection is clear of highway traffic so that light responsive devices 64a and 64b are each actuated, the devices 64a and 64b operate to pick up relays LR1 and LR2, respectively. The pick up of relays LR1 and LR2, open, at back contacts 76 and 77, respectively, the previously traced stick circuit for relay R2, with the result that relay R2 releases at the end of its slow release period. However, in the event that the intersection is not clear of highway traffic so that one or both of the light beams emitted from the lamps 64a is interrupted, the light responsive device controlled by such beam remains unactuated with the result that the relay controlled thereby retains its back contact closed to complete the stick circuit for relay R2. It is apparent from the foregoing that operation of exit gate XG1 is initiated only when the intersection is clear of highway traffic so that devices 64a and 64b are actuated by light rays emitted from their associated sources for a period longer than both of the delay positions of relay 22. It follows that operation of the exit gates is prevented by the presence of vehicles operating on highway H intermediate the pairs of highway crossing gates, with the result that when a train approaches the intersection to control the entrance gates to their obstructing positions, such vehicles are not “trapped” upon the intersection, but are permitted to pass the intersection and the exit gate before the operation of such gate is initiated. It should be noted that devices 64e and 65b control a stick circuit for relay R2, with the result that once relay R2 is released, further control of that relay by the light responsive devices can be established only when relay R2 is picked up over its pick-up circuit and this latter circuit is open.

The releasing of relay R2 completes an easily traced energizing circuit for field winding 61 for motor 23 of gate XG1, which circuit also includes the current source, contact 54—55 of circuit controller XJ1, and back contacts 103 and 105 of relay R2. Relay R2 released also completes an energizing circuit for armature winding 62 of the motor 23 of gate XG1, this circuit also including the current source, contact 54—55 of circuit controller XJ1, and back contact 104 of relay R2. The polarity of current supplied to the field and armature windings of motor 23 of gate XG1 is now such that its gate arm is operated to its obstructing position. When the gate arm of gate XG1 is operated to its 60° position, contact 54—55 of circuit controller XJ1 closes to complete an energizing circuit for the lamps 63 provided on that gate arm. Operation of gate XG1 is terminated when contact 54—55 opens at the 5° position of the gate arm, the arm being controlled by gravity to its full-down position.

When the train passes the intersection and vacates section D—E, relay TRX picks up to complete the circuits to reenergize relays R1, R2 and TPR1. The picking up of relay R1 establishes an energizing circuit for armature winding 62 of the motor 23 of gate NG1, which circuit previously may be traced from terminal B through contact 53—57 of circuit controller NJ1, front contact 107 of relay R1 and armature 62 to terminal C. Relay R1 also establishes an energizing circuit passing from terminal B through contact 53—57 of circuit controller NJ1, front contact 108 of relay R1 to terminal winding 61 of the motor of gate NG1, and front contact 108 of relay R1 to terminal C. It should be noted that the polarity of the current supplied to field winding 61 of the motor of gate NG1 when relay R1 is picked up is the reverse of the current supplied to winding 61 when relay R1 is released, so that gate NG1 operates to actuate its gate arm to its vertical position. The picking up of relay R2 completes an energizing circuit for armature winding 62 of motor 23 of gate XG1, this circuit including a current source, contact 53—57 of circuit controller XJ1 and front contact 110 of relay R2. Relay R2 also completes a circuit passing from terminal B through contact 53—57 of circuit controller XJ1, front contact 111 of relay R2, field winding 61 of the motor of gate XG1, and front contact 112 of relay R2 to terminal C, with the result that gate XG1 operates to actuate its gate arm to its raised position since the current flowing in field winding 61 is pole changed. It should be noted that lamps 63 provided on the gate arms of gates NG1 and XG1 are energized over their previously traced circuits until each arm reaches its 60° position, whereupon contact 53—57 of circuit controllers NJ1 and XJ1, respectively, are operated to deenergize the lamps as well as to open the motor circuits. The picking up of TPR1 opens back contacts 99, 96 and 99, and closes front contacts 101 and 97, contact 70 completing the previously tracked circuit for relay R2. Relay R2 picks up to close its front contact 71 interposed in the energizing circuit for relay TPR2 to thereby prepare that circuit. The closing of front contacts 102 and 103 of relay R2 prevents the previously traced “proceed” circuit for signal SS (which circuit remains open until relay TPR3 is picked up). The opening of back contacts 99, 96 and 99 opens the circuits previously traced for relay NF and signal SX. Signal SX becomes deenergized and ceases to exhibit its warning indication to highway users, while relay NF becomes deenergized to steadily illuminate the lamps 66 of signal SS, which lamps still display their “stop” indications. When the gate arms of gates NG1 and XG1 are operated to their 60° position and contacts 99—59 of each circuit controller NJ1 and XJ1 are closed, the circuit previously traced for relay TPR3 is completed whereupon that relay picks up to complete the “proceed” circuit for signal SS, so that signal SS now displays steady “proceed” indication. In this connection, it should be noted that signal SS is controlled to its “stop” indication whenever a gate arm is below its 60° position, in which position such arm will effect at least a partial obstruction of its associated highway lane. It can be seen, therefore, that signal SS will display its “stop” indication whenever any one of the gate arms is positioned so as to effect an obstruction.
of the highway, to thereby warn highway users against running into such obstructing arm or arms. When the gate arm of each gate NGI and XG1 is operated to its 65° position, further operation of the arm is terminated by the opening of contact 53—57 of its associated circuit controller, whereupon the apparatus of Fig. 1 is restored to its normal condition as illustrated in the drawings.

The operation of the apparatus of Fig. 1 for a westbound train operating over track Z is substantially similar to the operation just described for an eastbound train operating over track Y, as is readily apparent from an inspection of Fig. 1.

Further detailed explanation is deemed unnecessary except to point out that for a westbound train relay TRZ functions as the control track relay.

From the foregoing, it is readily apparent that I have provided novel and improved means for controlling highway crossing protection apparatus, particularly in view of the fact that operation of highway crossing gates is controlled to prevent traffic from being “trapped” on the intersection; that the indications displayed by three-indication signals are at times controlled by the position of associated highway crossing gate arms to warn traffic against running into such arms; and that operation of crossing gate arms, signals located on such arms, and indications displayed by single and multiple indication signals are all controlled by train responsive means to provide the maximum protective features for railway-highway intersections.

Although I have herein shown and described only a highway crossing protection 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 with a stretch of railway track intersected by a highway, a pair of highway crossing gates for each side of the intersection, said pairs of gates each located at a selected point along said highway and comprising an entrance gate operable to an obstructing position for preventing highway traffic operating in the normal direction of traffic from entering the intersection and an exit gate operable to an obstructing position for preventing highway traffic operating in the reverse direction of traffic from entering the intersection, control means governed by traffic operating over said stretch of railway for controlling at least one of said entrance gates to the obstructing position, other control means for controlling at least one of said exit gates to the obstructing position, a plurality of sources of light, means governed by said entrance gate when operating to its obstructing position for energizing said sources of light, a plurality of light responsive devices one for each source of light and adapted to be controlled by rays emitted from its associated source of light, and means effective only when each light responsive device is actuated for a predetermined period of time by light rays emitted from its associated source of light for rendering said other control means effective for controlling said exit gate to the obstructing position.

2. In combination, a stretch of railway track intersected by a highway, a pair of highway crossing gates for each side of the intersection, said pairs of gates each located at a selected point along said highway and comprising an entrance gate operable to an obstructing position for preventing highway traffic operating in the normal direction of traffic from entering the intersection and an exit gate operable to an obstructing position for preventing highway traffic operating in the reverse direction of traffic from entering the intersection, control means governed by traffic operating over said stretch of railway for controlling at least one of said entrance gates to the obstructing position, other control means for controlling at least one of said exit gates to the obstructing position, a plurality of sources of light, means governed by said entrance gate when operating to its obstructing position for energizing said sources of light, a plurality of light responsive devices one for each source of light and adapted to be controlled by rays emitted from its associated source of light, and means effective only when each light responsive device is actuated for a predetermined period of time by light rays emitted from its associated source of light for rendering said other control means effective for controlling said exit gate to the obstructing position.

3. In combination, a stretch of railway track intersected by a highway, a pair of highway crossing gates for each side of the intersection, said pairs of gates each located at a selected point along said highway and comprising an entrance gate operable to an obstructing position for preventing highway traffic operating in the normal direction of traffic from entering the intersection and an exit gate operable to an obstructing position for preventing highway traffic operating in the reverse direction of traffic from entering the intersection, control means governed by traffic operating over said stretch of railway for controlling at least one of said entrance gates to the obstructing position, a source of light, means controlled by the operation of said entrance gate to the obstructing position for energizing said source of light, a light responsive device adapted to be controlled by light rays emitted from said source of light, a control relay for at least one of said exit gates, means governed by said gate control relay when released for operating said exit gate to the obstructing position, a pick-up circuit for said exit gate control relay governed by traffic operating over said stretch of railway, a stick circuit for said exit gate control relay, and means governed by said light responsive device operative when actuated by light rays emitted from said source for controlling said stick circuit.

4. In combination, a stretch of railway track intersected by a highway, a flashing light type highway crossing signal and a highway crossing gate both located adjacent such intersection, a track relay responsive to traffic conditions in a given zone of said stretch adjacent the intersection, means controlled by said track relay for operating said gate between an obstructing and a non-obstructing position, a time element device also controlled by said track relay, a flasher relay for flashing the lights of said signal and operative at either of two rates, a control relay for selecting between said two rates of operation for the flasher relay, and a circuit for said control relay controlled by said time element device and by said highway crossing gate whereby to vary the rate of operation of said flasher relay controlled by said time element device or by said highway crossing gate whereby to vary the rate of operation of said flasher relay controlled by said time element device and by said highway crossing gate whereby to vary the rate of operation of said flasher relay controlled by said time element device or by said highway crossing gate whereby to vary the rate of operation of said flasher relay controlled by said time element device and by said highway crossing gate whereby to vary the rate of operation of said flasher relay controlled by said time element device or by said highway crossing gate whereby to vary.
intersected by a highway, a three-indication highway crossing signal and a highway crossing gate both located adjacent such intersection, a track relay responsive to traffic conditions in a given zone of said stretch adjacent the intersection, means controlled by said track relay for operating said crossing gate between an obstructing position and a non-obstructing position, means also controlled by said track relay for controlling said signal to display a clear or a caution indication according as said given zone is unoccupied or occupied, a time element device also controlled by said track relay, a control relay for controlling said signal to display its caution indication or its danger indication, and a circuit for said control relay controlled by said time element device and by said crossing gate whereby to control said signal to its danger indication at the expiration of a preselected time interval of said time element device or at a predetermined point in the operation of said crossing gate.

6. In combination, a stretch of railway track intersected by a highway, a highway crossing gate located adjacent such intersection and capable of being operated between an obstructing and a non-obstructing position, a track relay responsive to traffic conditions in a given zone of said stretch adjacent such intersection, a gate control relay for controlling the operation of said crossing gate, a pick-up circuit for said gate control relay controlled by said track relay, a stick circuit for said gate control relay, and means responsive to highway traffic conditions at said intersection for holding said stick circuit completed until said intersection is cleared of highway traffic.

7. In combination, a stretch of railway track intersected by a highway, a highway crossing signal located adjacent such intersection and capable of being operated between an obstructing and a non-obstructing position, a track relay responsive to traffic conditions in a given zone of said stretch adjacent such intersection, means controlled by said track relay for projecting a beam of light across said intersection in the path of highway traffic traversing the intersection, light-responsive means controlled by said beam of light, a gate control relay for controlling the operation of said crossing gate, a pick-up circuit for said gate control relay controlled by said track relay, and a stick circuit for said gate control relay controlled by said light-responsive means in such manner that said gate control relay is held energized to prevent operation of said crossing gate until the intersection is clear of highway traffic.

JOHN W. LOGAN, Jr.