June 12, 1962 C. L. SWANTON 3,038,991

HIGHWAY CROSSING PROTECTION SYSTEM

Filed June 27, 1961 4 Sheets-Sheet 1

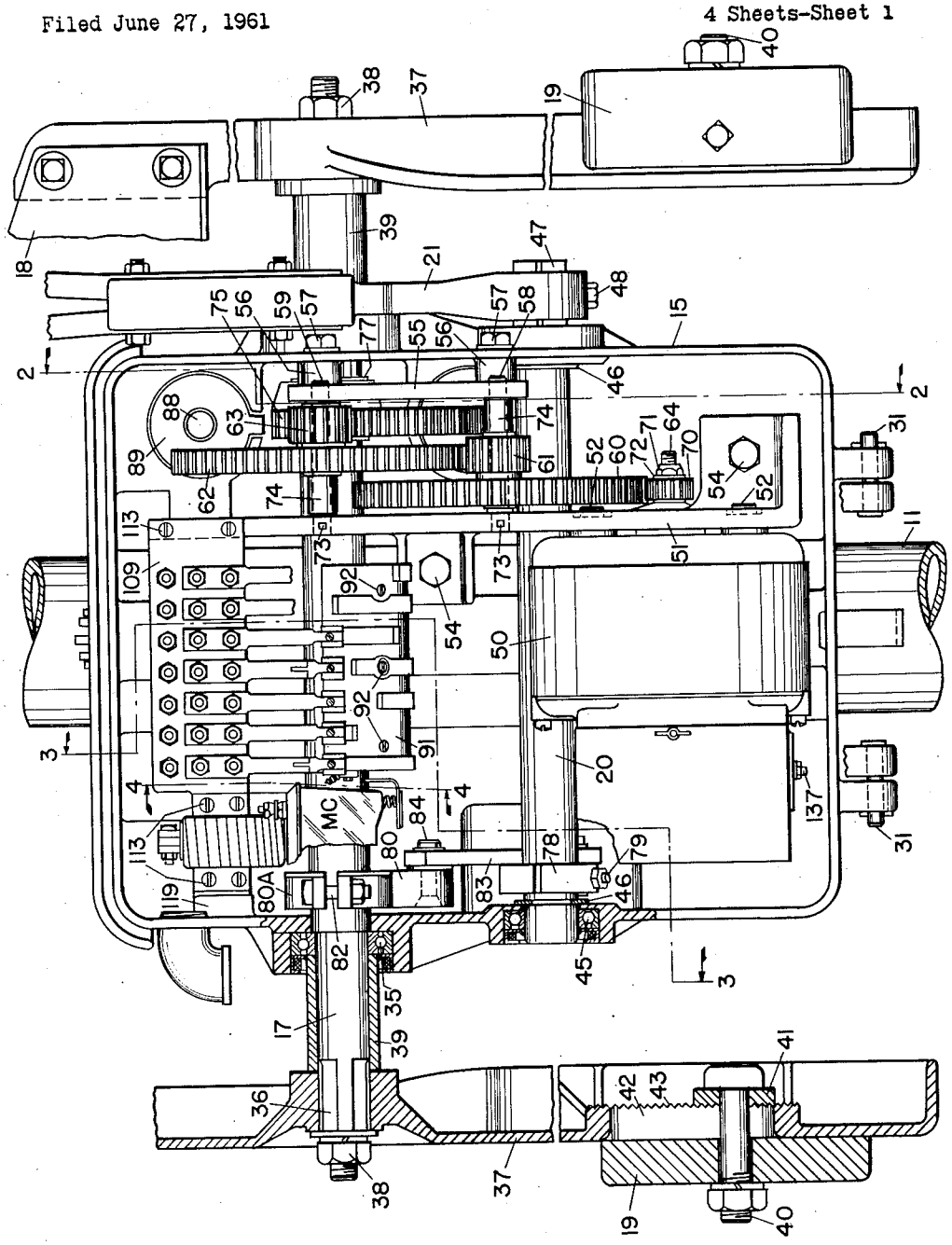


FIG. 1.

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Filed June 27, 1961 4 Sheets-Sheet 2

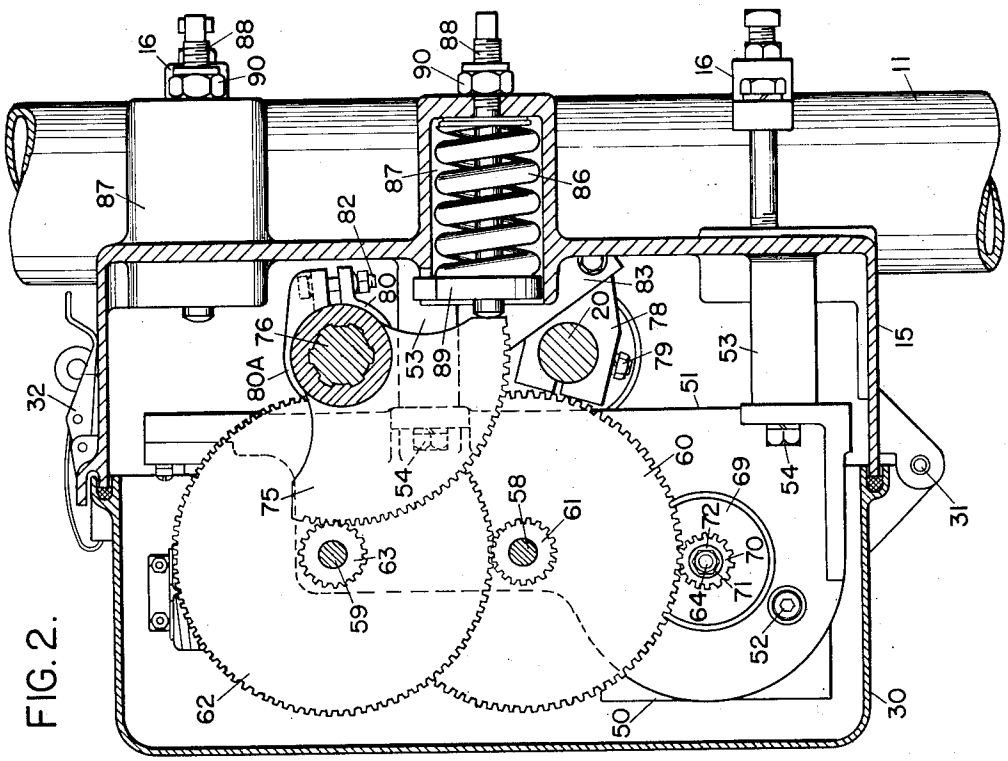


FIG. 2.

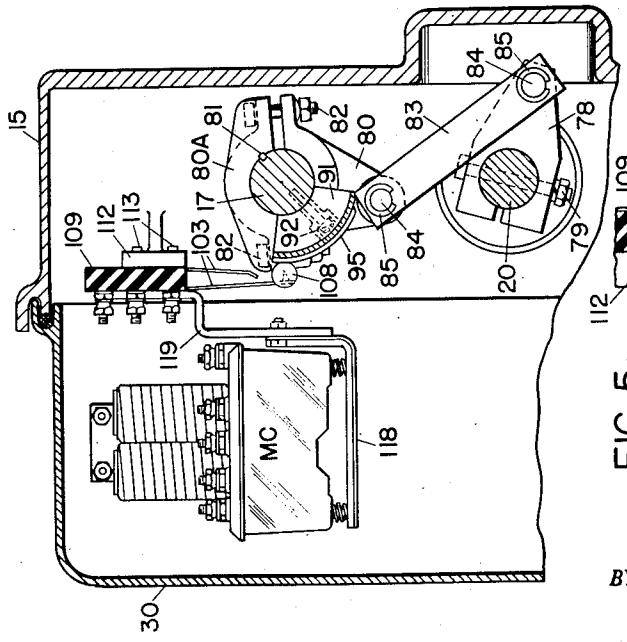


FIG. 3.

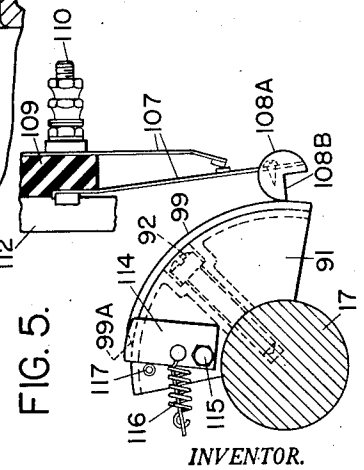


FIG. 5.

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HIGHWAY CROSSING PROTECTION SYSTEM

Filed June 27, 1961 4 Sheets-Sheet 3

FIG. 8.

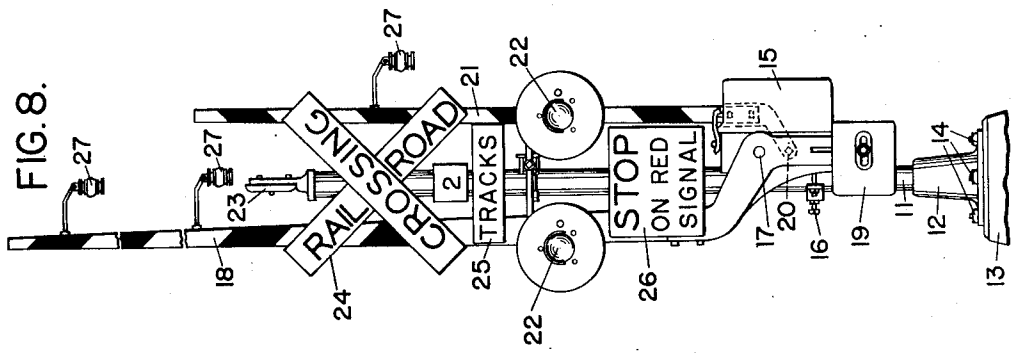


FIG. 7.

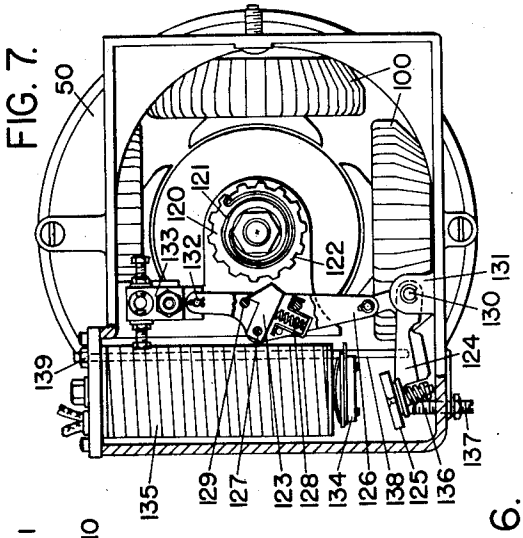


FIG. 6.

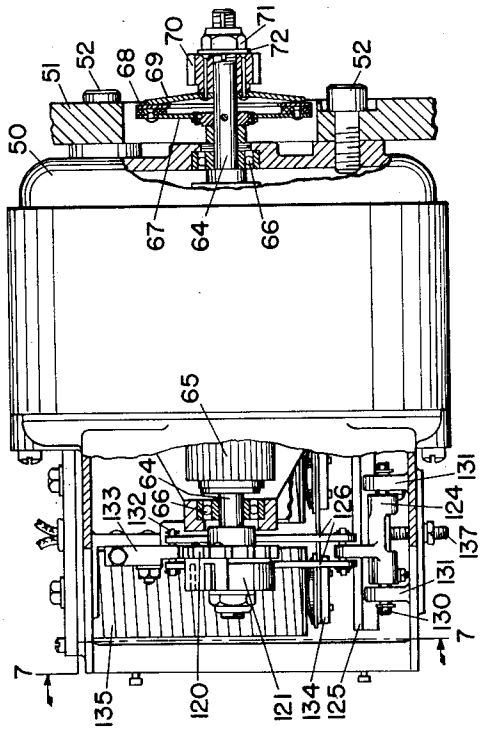
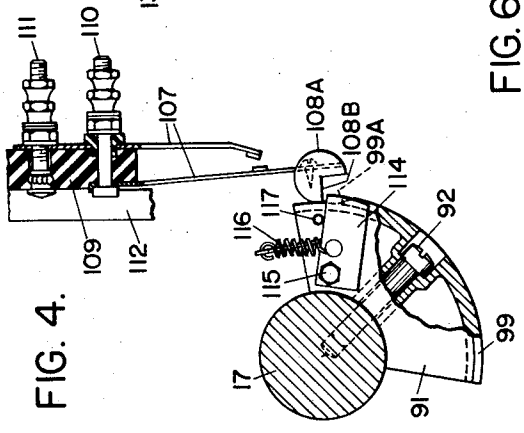


FIG. 4.



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HIGHWAY CROSSING PROTECTION SYSTEM

Filed June 27, 1961 4 Sheets-Sheet 4

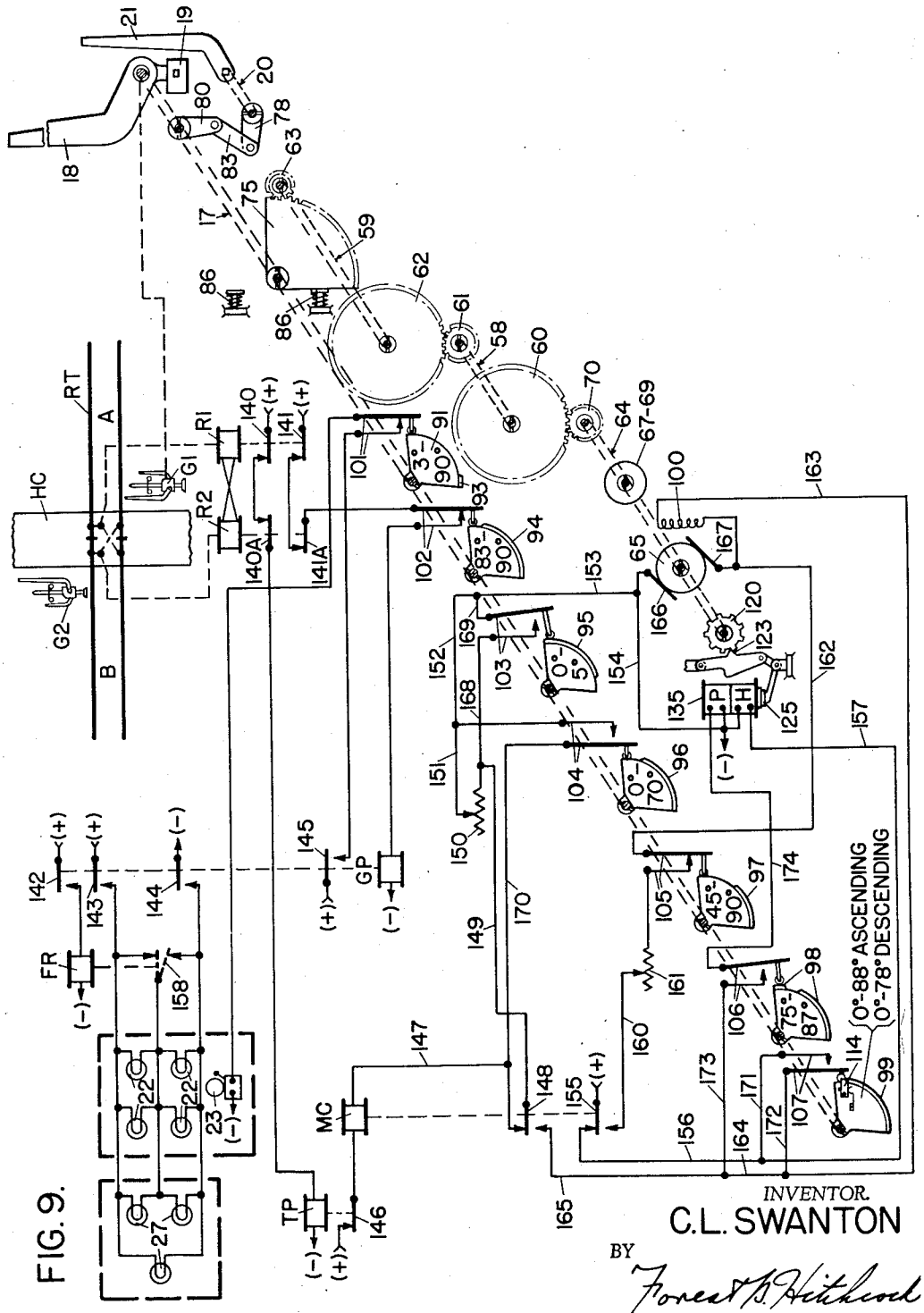


FIG. 9.

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United States Patent Office 3,038,991 Patented June 12, 1962

3,038,991

HIGHWAY CROSSING PROTECTION SYSTEM

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Filed June 27, 1961, Ser. No. 119,954
5 Claims. (Cl. 246—125)

This invention relates to highway crossing control systems for railroads and more particularly relates to the crossing gate mechanisms and associated devices used for vehicle and pedestrian grade crossing protection.

At intersections where highways cross over railroad tracks and a train has the right of way over highway traffic, the highway traffic is halted before and during the passage of a train by means of flashing red lights, warning bells and gate arms which are lowered to extend across the highway lanes and sidewalks. Such devices are provided one one each side of the railroad right of way to halt traffic in the highway lanes for both directions. The devices are automatically operated by a train as it approaches the highway crossing from either direction.

Each crossing protection device comprises in general a pole support to which is attached the crossing gate mechanism with its associated gate arms, flashing lights, warning bells and warning signs. The gate arms are normally positioned in an upright vertical clear position with the flashing lights and warning bells deenergized, thus signifying that the highway is open to traffic. These gate arms are partially counterbalanced to facilitate power operation thereof to a vertical position, but the balance is such that they are still gravity biased towards a horizontal position, which position would be assumed upon a power failure.

Gravity movement alone of the gate arms to a horizontal position under normal operation conditions is sometimes adversely affected by weather conditions, such as wind, snow and ice or the like. The speed of the gate arm movements may be too fast under some conditions and result in damage; whereas, under other conditions, high wind may retard or even prevent a movement of the gate arm to a horizontal danger position.

The present invention provides a gate operating mechanism which is compact and light in weight, simple in structure, efficient and fast in operation, and easy to maintain. Also, a control means is provided which controls the gate arm movements in both directions. Although the gate arms are normally gravity biased towards a horizontal position for fail-safe reasons, provision is also made to partially power drive the gate arms to a horizontal position. Such power drive downward is effective for approximately half the arcuate travel of the gate arms, whereupon the motor armature is effectively snubbed to slow the motor speed prior to the time the gate arms reach a horizontal position. Thus, the speed of the gate arm movements are under fairly uniform control at all times.

Provision is also made to have the gate arms latched in their vertical clear positions. Under normal operating conditions, the motor drives the gate arms to their vertical clear positions through a clutch and a gear train. Circuit controller means are provided so that the motor current is cut off and the motor armature is magnetically latched upon arrival of the gate arms at their vertical clear positions. The circuit controller also controls the operation of the associated flashing lights and the warning bell.

The mechanism arrangement is such that the motor drive means and the gearing operate a main shaft to which the highway gate arm is attached. A linkage arrangement connects the main shaft to a secondary shaft on which is mounted the sidewalk gate arm. The circuit

controller commutator is mounted directly on the main shaft so that it rotates through an approximate ninety degrees arc the same as the gate arm. Stationary contacts are operated by cams mounted on the circuit controller commutator. A special snap acting contact arrangement provides a quick break for the heavily loaded motor control circuit, thus minimizing the arcing and burning of tht contact fingers.

The operation of the gate arms, flashing lights and the warning bell is controlled through interlocking type relays which are normally energized by the track circuits. The entrance of a train into the approach block adjacent the highway crossing causes a shunting of the associated track relay and the opening of its front contacts to deenergize the control relays to cause release of the motor magnetic latching device and operation of the gate arms to a horizontal danger position. The flashing lights and the warning bell are also set into operation. The passage of the train beyond the highway crossing will remove the train shunt from the approach section and permit the associated track relay to again become energized, thus causing operation of the gate arms to their vertical clear positions wherein they are again magnetically latched.

Under normal operating conditions the deenergization of either the track relays or the control relays causes operation of the gate arms to a horizontal danger position. Such an arrangement therefore insures that a power failure would also cause operation of the gate arms to a horizontal danger position due to the gravity bias feature, thus providing fail-safe protection for the highway traffic.

Means have also been provided to insure proper operation of the mechanism during momentary loss of power when the gate arm is in the clear position. Under such conditions, the gate arm would move downward to a certain specified position before re-ascending, so that the electro-magnetic latching means can be reactivated to once again latch the gate arm when it reaches its clear vertical position.

Other objects, purposes and characteristic features of the present invention will be partly apparent and partly pointed out as the detailed description progresses. In describing the invention in detail, reference will be made to the accompanying drawings wherein various parts will be referred to by distinctive reference characters and wherein:

FIG. 1 is a front elevational view of a highway crossing gate mechanism of the present invention with the cover removed and the crossing gate attached thereto, certain of the parts having been shown in cross section;

FIG. 2 is a side elevational sectional view of part of the apparatus shown in FIG. 1 as taken substantially on the line 2—2 of FIG. 1 as viewed in the direction of the arrows;

FIG. 3 is a side elevational sectional view of another part of the apparatus shown in FIG. 1 as taken substantially on the line 3—3 of FIG. 1 as viewed in the direction of the arrows;

FIG. 4 is an enlarged sectional view of one of the circuit controller contacts shown in FIG. 1 as taken substantially on the line 4—4 of FIG. 1 as viewed in the direction of the arrows;

FIG. 5 is a view similar to FIG. 4 except that it shows the circuit controller and its cooperating contact in their other operated positions;

FIG. 6 is an enlarged side view of the motor shown in FIG. 1 partly shown in section to illustrate the clutch connection between the motor shaft and the gear train and also the electro-magnetic means for latching the motor shaft;

FIG. 7 is an end sectional view of the apparatus shown

in FIG. 6 as taken substantially on the line 7—7 of FIG. 6 as viewed in the direction of the arrows;

FIG. 8 is an outline view of the complete highway crossing gate apparatus of the present invention shown to illustrate the organization of the various devices; and

FIG. 9 is a schematic view of the complete apparatus and the control circuits therefor of the present invention and is shown in simplified form rather than specific detail to more clearly illustrate the operation thereof.

Referring first more particularly to FIG. 8 of the drawings, there has been shown for illustration purposes, an outline of a typical highway crossing gate structure. The supporting pole **11** and its base **12** are mounted on a suitable foundation **13** and anchored thereto by bolts **14**. To the pole **11** is attached the gate operating mechanism casing **15** by means of clamps and bolts **16**. Protruding from the mechanism casing **15** is the main shaft **17** to which is attached the highway gate arm **18** and its associated counterweights **19**. Also protruding from the mechanism casing **15** is a secondary shaft **20** to which is attached the sidewalk gate arm **21**.

Also attached to the supporting pole **11** are the usual flashing lights **22**, a warning bell **23** and suitable warning signs **24**, **25** and **26**. The flashing lights **22** are in pairs and are mounted back to back so as to have indications in both directions. Also, mounted on the gate arms **18** and **21** are suitable two-way indication flashing lights **27**.

In operation, as will be explained more in detail hereinafter, the highway gate arm **18** would rotate in a counterclockwise direction and lower to a horizontal position across a highway whereas the short gate arm **21** would rotate in a clockwise direction and lower to a horizontal position across a sidewalk. Also, the bell **23** would sound during the lowering and raising of the gate arms and the various flasher lights **22** and **27** would be operable until such time as the gate arms **18** and **21** were restored to their normal vertical position.

Referring now more particularly to the gate arm operating mechanism as shown in FIGS. 1, 2 and 3 of the drawings, the mechanism is housed in the main casing **15** which is provided with a gasketed cover **30**. The cover **30** is hinged to the casing **15** as shown at **31** and may be latched thereto by a spring hasp and eye arrangement as shown at **32**, so that when opened the cover **30** will swing downward against the pole **11** and expose the mechanism.

The main shaft **17** is mounted transversely in the casing **15** and is journaled in the ball bearings **35** which are mounted one in each of the side walls of the casing **15**. These ball bearings **35** are of the type which are packed with lubricant and suitably sealed for life use. The ends of the shaft **17** extend through the bearings **35** to the outside of the casing **15** and are provided with splined surfaces **36** and a reduced threaded portion to facilitate the mounting of the highway gate arm **18**.

The gate arm **18** is separated into two forked ends at its base portion and each forked end is provided with a mounting arm **37**. The structure is such that the base portion of the gate arm **18** and the mounting arms **37** straddle the mechanism casing **15** with a mounting arm **37** attached to each end of the shaft **17**. Each mounting arm **37** fits over its respectively splined end shaft portion **36** and is held in place by means of a nut **38** threaded onto the reduced threaded end portion of the shaft **17** with suitable spacing and lock washers interposed therebetween. Suitable bushings **39** on the shaft **17** are located between the mounting arms **37** and the bearings **35** to properly positions the various elements and prevent transverse movement of the shaft **17**.

As previously mentioned, the highway gate arm **18** is provided at its base end extremity with counterweights **19** to partially counter balance the bulk of the long gate arm which extends outward radially from the shaft **17** on which it is mounted. The proportion of counterbalance is such that the gate arm still can overcome the counterweights so that the gate arm may rotate from a vertical to a horizontal position by gravity. However, the partial counterbalance also facilitates rotary movement of gate arm to a vertical position by requiring less motor torque. These counterweights **19** are adjustably fastened to the mounting arm portions **37** of the gate arm **18** by means of a bolt **40** and a clamp **41**. The bolt **40** passes through an elongated hole **42** in the arm **37** and both of the contacting surfaces of the arm **37** and the clamp **41** are provided with stepped serrations **43** to hold the counterweight **19** in its adjusted position.

The secondary shaft **20** is also mounted transversely in the casing **15** and is journaled in the ball bearings **45** which are mounted one in each of the side walls of the casing **15**. The shaft **20** is provided with a groove and split retaining rings **46** located just inside the casing walls to prevent transverse movement of the shaft. The right hand end of the shaft **20** protrudes from the casing **15** and is provided with a portion **47** which is square in cross section to facilitate the mounting of the sidewalk gate arm **21** thereon. The hub of the gate arm **21** is provided with a squared opening therethrough to fit over the square shaft portion **47** and the gate arm **21** is held on the shaft **20** by means of a set screw **48** or the like.

The main shaft **17** and its associated highway gate arm **18** are rotated by means of a motor **50** through a clutch and a gear train arrangement which provides a speed reduction ratio of about 230 to 1 or the like as preferred in order to provide a suitable operating speed for the gate arm rotation. The main shaft **17** is connected to the secondary shaft **20** by means of a crank and link arrangement so that this secondary shaft **20** and its associated sidewalk gate arm **21** are rotated in an opposite direction at the same speed as the main shaft **17** and its associated gate arm **18**.

More specifically, the motor **50** is mounted on a supporting plate **51** by means of bolts **52**. This supporting plate **51** in turn is mounted to the inside back of the mechanism casing **15** by means of extending bosses **53** and bolts **54**. Another supporting plate **55** is mounted to the inside right wall of the casing **15** by means of extending bosses **56** and bolts **57**. Mounted in and between these two supporting plates **51** and **55** are two transverse shafts **58** and **59** upon which the gears and pinions **60**, **61**, **62** and **63** of the gear train are rotatably mounted.

The motor **50** (see FIG. 6) has its shaft **64** and associated armature-commutator assembly **65** journaled in ball bearings **66** which are mounted in the end walls of the motor casing, the right-hand end of the shaft **64** protruding therefrom. To this end of the shaft **64** is fixedly attached one of the clutch plates **67** in a manner whereby it rotates with the shaft. The other clutch plate **68** is attached to a resilient spider plate **69** which in turn is secured to the motor shaft pinion gear **70**. This pinion gear **70** is slidably mounted on the shaft **64** and held thereon by means of a nut **71** threaded onto the end of the shaft **64**. A keyed thrust washer **72** is disposed between the pinion gear **70** and the nut **71**. The pressure between the two clutch plates **67** and **68** is adjusted by means of tightening down the nut **71** against the pinion and its resilient spider clutch plate **69**.

In this connection it should be mentioned that the adjustment of the clutch drive between the motor shaft **64** and the pinion gear **70** under normal conditions should be the equivalent of a rigid connection, no slipping occurring. The main reason for the clutch drive is to prevent strain on the motor and mechanism in case of a gate arm breakage, in which case the counterweights **19** would place the weight and leverage on one end of the gate arm **18** with respect to the shaft **17**. Under such conditions, the torque exerted by the counterweight leverage would tend to drive the mechanism in reverse against the torque exerted by the motor and slippage through the clutch would be required to protect the motor.

It can now be seen that the motor **50** drives the pinion gear **70** through the clutch plates **67**—**68**. The pinion

gear 70 meshes with and drives the first reduction gear 60 and its associated integral pinion gear 61 which are rotatably mounted on the shaft 58. Likewise, the pinion gear 61 meshes with and drives the second reduction gear 62 and its associated integral pinion gear 63 which are rotatably mounted on the shaft 59. These shafts 58 and 59 are held in position against transverse movement by means of set screws 73 passing through the supporting plate 51. Suitable spacing bushings 74 position the gears 60—61 and 62—63 on their respective shafts 58 and 59.

The pinion gear 63 meshes with and drives a gear sector 75 which is fixedly mounted on the main shaft 17 by means of a splined portion 76 on the shaft and split retaining rings 77, thus providing a means for rotating the main shaft 17 and its associated highway gate arm 18. As previously mentioned, a crank and link arrangement connects the two shafts 17 and 20. A crank arm 78 is fixedly mounted on the shaft 20 by means of the bolt 79, whereas the crank arm 80 is adjustably mounted on the shaft 17. This crank arm 80 is a clamp arrangement having its cap portion 80A fixedly located on the shaft by a key 81. The two parts are then clamped together by means of the two bolts 82, thus permitting a slight rotary adjustment of the free end of the arm 80. A link 83 is connected between the free ends of the two crank arms 78 and 80 by means of pins 84 and split retaining rings 85.

As the gate arm 18 and its associated gear sector 75 and shaft 17 normally rotates through an arc of approximately ninety degrees, stops are provided to limit these movements in both directions. These stops are resilient in operation and are located within the mechanism casing 15 and are positioned to act on the gear sector 75 and limit the movements thereof. Each stop comprises a coiled compression spring 86 which is housed in a cylindrical well 87 formed in the mechanism casing 15. The spring is retained in the well 87 under compression by means of a stud 88, a keyed washer 89 and a nut 90. The head of the stud 88 retains the washer 89 which bears against the free end of the spring 86, the stud passing through the spring 86 and the base of the well 87. Adjustment of the nut 90 regulates the compression of the spring 86 and the key lug on the washer extending into a slot in the casing of the well housing 87 prevents turning of the washer 89 and the spring 86 during assembly and adjustment. These resilient stops provide a cushioning means for arresting the final movements of the gate arm and associated operating mechanism in both directions of movement as the side of the gear sector 75 comes to bear against the head of the stud 88.

The gate operating mechanism is also provided with a circuit controller comprising a plurality of cam operated contacts to open and close various circuits as will be explained more in detail hereinafter. The commutator 91 of circuit controller is of a general quadrant shape and is preferably made of cast aluminum or the like (see FIG. 4). Thus commutator 91 is fastened directly to the main shaft 17 by means of machine screws 92 and consequently also rotates through an arc of approximately ninety degrees.

The perimeter surface of the commutator 91 is provided with a plurality of raised cams 93 to 99 inclusive which are arranged to open and close the pairs of contact fingers 101 to 107 inclusive at various degrees of rotary movement of the commutator 91, as diagrammatically illustrated in FIG. 9. In each instance, one of the contact fingers of each pair of contact assemblies is movable by a cam against a spring bias and is provided at its free end with a cylindrical cam follower 108 made of nylon or other suitable hard insulation material, as shown in FIG. 3.

The various pairs of contact fingers 101 to 107 inclusive are each mounted on a terminal board 109 of insulating material by means of terminal posts 110 and 111 (see FIG. 4) in a manner whereby they are insulated from each other. The terminal board 109 is mounted on and extends between the supporting plate 51 and a lug 112 which extends from the sidewall of the casing 15, by means of screws 113.

The contact finger assembly 107 and its associated cam 99 differs from the other contact finger assemblies in it provides a quick break of the circuit which controls the current to the motor 50. This is necessary to minimize the arcing and burning of the motor control contacts due to the heavy current load required by the motor. As shown in enlarged detail in FIGS. 4 and 5, a latching dog 114 is mounted on the end of the commutator 91 by means of a shouldered pivot bolt 115 and is biased by a spring 116 against a stop pin 117. This latching dog 114 lies adjacent to the cam 99 and has its cam surface periphery on the same plane as the surface of the cam 99, so that the cam follower 108A spans both cam surfaces. As shown in FIG. 4, the latching dog 114 normally overlays the incline 99A on the cam 99 and the cam follower 108A is notched out to provide a flat side 108B which will bear against the side of the latching dog 114 upon a counterclockwise movement of the commutator 91.

Assuming now that the commutator 91 is to be rotated in a counterclockwise direction from its normal position as shown in FIG. 4 to its operated position as shown in FIG. 5 as would be the case in a gate arm movement from a vertical to a horizontal position, the cam follower 108A would bear against the latching dog 114 and cause it to rotate against the bias of the spring 116. Thus, the cam follower 108A would ride up the cam incline 99A and close the motor control contacts 107 at approximately the seventy-eight degree position and condition the motor circuit for future energization, as will be explained hereinafter. However, upon a movement of the commutator 91 from its operated position (FIG. 5) to its normal position (FIG. 4), the cam follower 108A would ride over the latching dog 114 and open the motor control contacts 107 instantly at the eighty-eight degree position as the edge 108B of the cam follower 108A dropped over the edge of the latching dog 114.

Also mounted within the mechanism casing 15 is a standard type two position neutral relay MC for the purpose of providing a local control for the motor 50, as explained hereinafter. This relay MC is resiliently mounted on a platform 118 which is attached to a bracket 119. The bracket 119 is also mounted on the terminal board 109 by means of the screws 113.

Referring again to the motor 50, as shown in FIGS. 6 and 7, an electromagnetic latching means is provided to latch the motor shaft 64 when the gate arm 18 is in its normal vertical position so that the motor current can be cut off and the gate arm 18 can be held in such vertical position against its gravity bias towards a horizontal position. A notched wheel 120 is mounted on the motor shaft 64 and is attached thereto by means of a tightly wound flat coil spring 121. One end of the coil spring 121 is fastened to the motor shaft 64 whereas the other end of the coil spring 121 is attached to the notched wheel 120. The notches 122 in the wheel 120 are located around its periphery and are positioned to cooperate with a latching dog 123 which is moved into and out of engagement with the notched wheel 120 by means of the armature movement of the electromagnetic device.

This electromagnetic device comprises in general a pivoted right angle lever arm 124 having an armature 125 attached to one end and having its other end pin connected to the free end of a pivotally mounted operating arm 126. Mounted between the two side plates of this operating arm 126 on a pivot pin 127 is the latching dog 123 which is biased by a spring 128 against a stop pin 129. The pivot pin 130 for supporting the angle lever arm 124 is mounted in fixed lugs 131 whereas the pivot pin 132 for supporting the operating arm 126 is mounted on an adjustable lug 133. This permits a slight lateral adjustment between the latching dog 123 and the notched wheel 120.

The armature 125 is spring mounted on the lever arm

124 and is positioned to be magnetically attracted to the pole pieces 134 of the electromagnetic core and coil structure 135. The spring 136 on the armature mounting is provided to cushion the armature when it seats against the pole pieces 134, thus preventing damage thereto due to any excessive movement of the lever arm 124 caused by back torque through the motor shaft 64. A rod 138 provides a positive stop for the upward movement of the lever arm 124 and is effective after a slight compression of the spring 136. This stop rod 138 is threaded at one end through the casing so that it may be adjustably positioned with respect to the lever arm 124. The adjusted position is maintained by a lock nut 139. The drop-away movement of the armature 125 and its associated lever arm 124 is limited by an adjustable stop bolt 137 which is similarly mounted in the casing.

Reviewing briefly the operation of the gate arm operating mechanism described above, it can be seen and understood that the motor 50 will drive the gate arms 18 and 21 in either direction through the clutch arrangement and pinion gear 67—70, the gear train 60—63 and the gear sector 75. Thus, the main shaft 17 and its associated highway gate arm 18 are rotated at a reduced speed through an arc of approximately ninety degrees are represented by the horizontal and vertical positions of the gate arm 18. The same is true of the shaft 20 and its associated sidewalk gate arm 21 because of its crank and link connection 78, 80 and 83 to the main shaft 17.

As the circuit controller commutator 91 is fastened directly to the main shaft 17, its various cams 93–99 also rotate through a ninety degree arc corresponding to the movements of the gate arm 18. Thus, the various contact combinations 101–107 are operated at certain intervals throughout the gate arm movement to open and close certain control circuits as will be explained in detail presently.

Generally speaking, the motor 50 drives the gate arm 18 from a horizontal zero degree position to an eighty-eight degree position, at which point the motor current is cut off and the momentum carries it through the vertical ninety degree position against its buffer stop 86—90. In this ninety degree or vertical position of the gate arm 18, the electromagnetic latching device is energized so that its latching dog 123 engages the notched wheel 120 and the motor shaft 64 is now latched. With the motor shaft 64 latched, a gravity movement of the gate arm 18 back towards its horizontal position is prevented except for a slight cushioned movement permitted by the coil spring 121. Thus, the coil spring connection between the motor shaft 64 and the notched wheel 120 prevents any excessive strain on the latching mechanism when the gate arm settles back in its clear vertical position.

When the gate arm 18 is about to descend across the highway due to the approach of a train, the electromagnetic latching device is deenergized, thus unlatching the motor shaft 64. Also, the windings 160 of the motor 50 will be reversely energized so that the gate arm 18 will be driven down to an approximate forty-five degree position, at which point the motor current is cut off. However, the gate arm 18 continues its downward movement due to momentum and gravity and actually drives the motor, thus causing current to be generated which is diverted through the motor windings in a reversed direction to snub the motor and the downward movement of the gate arm 18. This action slows the momentum of the gate arm 18 as it approaches its zero or horizontal danger position, thus providing a smooth stop against its buffer stop 86—90.

Referring now to FIG. 9 of the drawings, the complete highway crossing protection system of the present invention has been illustrated in conventional diagrammatic form to more clearly understand the operating characteristics thereof. For the purpose of simplification, only one railroad track RT divided into two track sections A and B has been shown, one track section on each side of the highway crossing HC. The usual highway crossing control track circuits have been illustrated conventionally as controlling the interlocking track relays R1 and R2, it being understood that the presence of a train in either track section A or B shunts one of the relays R1 or R2, thus initiating operation of the crossing gates G1 and G2. It should also be understood that two or more tracks may be present at the highway crossing and the control circuits are arranged to operate the gates during the presence of a train on either track approaching from either direction.

The drawing FIG. 9 illustrates only the mechanism of the crossing gate G1 and the controls therefor but it should be understood that the local track relays R1 and R2 as well as their associated control relays TP, GP and FR, also govern the operation of the other crossing gate G2 and its associated flashing lights 22 and 27 and the warning bell 23 in a similar manner.

Under normal conditions with the gate arms 18 and 21 in their vertical positions and the highway HC clear for vehicle traffic, the track relays R1 and R2 are energized, thus closing circuits through their front contacts 140—140A and 141—141A to energize the control relays TP and GP. The energizing circuit for the relay GP also includes the closed circuit controller contacts 102 which are controlled by the cam 94. This relay GP controls the energization of the flashing relay FR, the flashing lights 22 and 27, and the warning bell 23 through its contacts 142, 143, 144 and 145. The circuit for the warning bell 23 also includes the closed circuit controller contacts 101 which are controlled by the cam 93. The relay TP controls the energization of the motor control relay MC through its contact 146.

Under such clear highway conditions, the circuits for the flashing relay FR, the flashing lights 22 and 27, and the warning bell 23 are open at their respective contacts 142, 143, 144 and 145 of the relay GP, and consequently are deenergized. However, the motor control relay MC is energized through the closed contact 146 of the relay TP so that the holding coil H of the core and coil structure 135 of the electromagnetic device is energized, thus causing the locking dog 123 to latch the notched wheel 120 and retain the gate arm 18 in its clear ninety degree vertical position as previously explained. This energizing circuit for the relay MC may be traced as follows: from the positive side (+) of the source of current, front contact 146 of the relay TP, winding of the relay MC, wire 147, front contact 148 of the relay MC, wire 149, variable snub resistor 150, and wires 151, 152, 153 and 154 to the negative side (—) of the current source. The energizing circuit for the holding coil H may be traced as follows: from (+), front contact 155 of the relay MC, wires 156 and 157, through the winding of the holding coil H to (—).

Assuming now that a train enters the track section A from the right, the track relay R1 will be deenergized to drop away its armature and open its front contacts 140 and 141, thus deenergizing the relays TP and GP. With the relay GP deenergized, its back contacts 142, 143 and 144 will close circuits to energize the flashing relay FR and supply energy to the flashing lights 22 and 27, the contact 158 of the relay FR controlling the flashing of the lights. Also, the closing of the back contact 145 of the GP relay supplies energy to the warning bell 23 through the closed circuit controller contacts 101. Thus, the flashing of the lights 22 and 27 and the sounding of the bell 23 give warning to traffic that a train is approaching and the gates 18 and 21 are about to descend.

The deenergization of the relay TP causes its front contact 146 to open and deenergize the motor control relay MC, thus dropping its contacts 148 and 155 from their front to their back contact positions. The dropping of the contact 155 breaks the energizing circuit through wires 156 and 157 to the holding coil H of the electromagnetic device, thus unlatching the motor shaft 64 and permitting a downward movement of the gate arms 18 and 21. Also, the closing of the back contact 155 closes a

circuit for energizing the motor winding **100** to permit the motor to assist in driving the gate downward under restricted conditions for reasons previously stated.

As previously mentioned, the gate arm **18** is gravity biased towards a horizontal position so that little motor torque is required at the start of a power drive downward movement. Consequently, the motor current is partially diverted so that only a portion passes through the motor winding **100**. The circuit may be traced as follows: from (+), back contact **155**, wire **160**, limit resistor **161**, closed contacts **105** of the circuit controller and wire **162** to the motor, at which point the current is divided. One circuit permits part of the current to pass through the motor armature **65** and wire **154** to (—). The other circuit passes through the motor winding **100**, wires **163**, **164** and **165**, back contact **148**, wire **149**, snub resistor **150**, and wires **151**, **152**, **153** and **154** to (—). Thus, the motor provides sufficient torque to drive the gate arm **18** downward.

When the gate arm **18** reaches the forty-five degree position, the cam **97** opens the circuit controller contacts **105** and current is cut off from the motor winding **100**. However, due to momentum and gravity, the gate arm **18** continues its downward movement and actually drives the motor armature **65**, thus causing current to be generated which is passed through the snub resistor **150** and the motor winding **100** in a reverse direction through a circuit which may be traced as follows: from the armature brush **166** through wires **153**, **152** and **151**, snub resistor **150**, wire **149**, back contact **148** of the relay MC, wires **165**, **164** and **163**, and motor winding **100** to the other armature brush **167**. This action causes the motor to produce a slight braking effect which slows the gate arm movement until it reaches a position five degrees from the zero or horizontal position. At this point of the gate arm movement, the cam **95** closes the circuit controller contacts **103**, thus shunting out the snub resistor **150** in the circuit just traced, the current now passing from wire **149** through wire **168**, contacts **103** and wire **169** to wire **153**. The motor winding **100** now receives the full load of current and the reverse action of the motor over the last five degrees of gate arm movement will produce a braking effect sufficient to bring the mechanism to a smooth stop against its associated spring buffer **86—90** as the gate arm **18** reaches its zero horizontal danger position across the highway HC.

With respect to the power drive downward movement from the ninety to the forty-five degree position as just described above, such power drive downward may not be necessary due to the presence of wind or ice conditions of a nature having a tendency to help the gravity bias downward movement of the gate arm **18**. Under such conditions, if the speed of the gravity down movement exceeded that of the motor torque, the gate arm **18** would actually drive the motor armature **65**, thus again causing the motor to act as a generator and slow the time of descent as described above.

It should now be mentioned that for convenience purposes, each of the cam quadrants **93–99** has been marked with degree marks, such as for example 3°–90° on cam **93**, which indicates the degrees of gate arm movement at which a particular cam holds its associated contacts closed. In this respect, the horizontal position of the gate arm **18** is considered the zero position whereas the vertical position is the ninety degree position.

It can now be seen that during the downward movement of the gate arm **18**, the cam **93** opened its contacts **101** at the three degree position, thus silencing the warning bell **23** even though the relay GP is still deenergized due to the presence of a train in the track section A. Also, it can be seen that the cam **94** has opened the circuit controller contacts **102** at the eighty-three degree position. This breaking of the circuit to the GP relay had no effect thereon as such relay was already deenergized. However, the open contacts **102** do prevent the relay GP from becoming again energized until the gate arm **18** passes the eighty-three degree position on its way up, even though the track relay **R1** is again energized and its contact **141** closed. Thus, the circuits are arranged so that the lights **22** and **27** will flash from the time the gate arm **18** starts down until the time it reaches the eighty-three degree position on the way back up. However, the warning bell sounds only during the time in which the gate arm movements in both directions are actually occurring. Certain other cam and circuit controller contact movements take place during the downward movement of the gate arm **18** but they merely condition circuits for the upward movement of the gate arm **18**, as will now be explained.

Assuming now that the train passed through the track section A and beyond the highway crossing HC, and of course assuming that no train is approaching on another track, the track relay **R1** will again become energized through the conventional track circuits, and its front contact **140** will again close to complete the energizing circuit for the relay TP. With relay TP energized, an energizing circuit for the motor control relay MC is completed which may be traced as follows: from (+) to front contact **146** of relay TP, winding of the relay MC, wires **147** and **170**, closed circuit controller contacts **104**, and wires **152**, **153** and **154** to (—). With the motor control relay MC now energized, a circuit is completed to energize the motor winding **100** which may be traced as follows: from (+) to front contact **155** of relay MC, wires **156** and **171**, closed circuit controller contacts **107**, wires **172** and **163**, motor winding **100** and motor armature **65**, and wire **154** to (—).

With the motor winding **100** energized, the gate arm **18** will move upward under full motor power until it reaches an eighty-eight degree position, at which point the cam **99** and its associated latching dog **114** opens the circuit controller contacts **107** rather quickly to minimize arcing, as explained in detail in connection with FIGS. 4 and 5. With the motor power cut off at the eighty-eight degree position by the open circuit controller contacts **107**, the gate arm **18** will continue its movement to the ninety degree position due to its momentum.

When the motor control relay MC was energized at the start of the upward gate arm movement, the circuit through its front contact **155** was also completed for energizing the holding winding H of the electromagnetic latching device as previously described. However, the magnetic force generated by this energized winding H is insufficient to pick up the armature **125** and its associated latching apparatus, but is sufficient to hold the armature **125** once it is picked up. Thus, a pick-up winding P is also provided, which, when energized, combines its magnetic force with the force of the holding winding H to pick up the armature **125**. The energization of this pick-up winding P occurs as the gate arm **18** moves through the seventy-five degree position to the eighty-seven degree position. This energization circuit may be traced as follows: from (+) through front contact **155**, wires **156** and **171**, closed circuit controller contacts **107**, wires **172**, **164** and **173**, circuit controller contacts **106** closed between the seventy-five and eighty-seven degree positions, wire **174** and through the winding P to (—).

With the armature **125** now picked up and held up by the holding winding H, the electromagnetic latching device is conditioned so that when the gate arm **18** does reach its ninety degree vertical position, the latching dog **123** will engage the notched wheel **120** and hold the motor shaft **64** and associated gate arm **18** in position, all as described in detail hereinbefore.

Referring once again to the energizing circuit for the motor control relay MC previously described, it can be seen that this circuit will be opened at the circuit controller contacts **104** by the cam **96** as the gate arm **18** moves through the seventy degree position on its upward movement. However, the relay MC will not become de-

energized because an alternate energizing circuit was also established through its own front contact 148 from the wire 147 to the wire 149, snub resistor 150 and wires 151 and 152 to wire 153. This is the same circuit previously described for maintaining the relay MC energized during the interval of time that the gate arm 18 is in the clear vertical position and the holding coil H and its associated electromagnetic latching device is activated.

Such an interconnection of circuits is necessary to proper operation of the gate arm mechanism if there should be a momentary loss of energy to the motor control relay MC. Assuming that a loss of energy should occur due to accidental shunting of the track relays R1 or R2 or other reasons, deenergization of the motor control relay MC would release the electromagnetic latching device and permit a downward fail-safe movement of the gate arm 18 due to gravity. If the power failure should continue, the gate arm 18 would continue on downward to its horizontal danger position where it would remain until power was restored.

However, if the loss of energy were just momentary, causing the release of the electromagnetic latching device, the present arrangement insures that the gate arm 18 would have to descend at least to its seventy degree position where the closure of the circuit controller contacts 104 would again energize the motor control relay MC. With the relay MC once again energized, it would be maintained energized through its own front contact 148 and the alternate circuit when the circuit controller contacts 104 were once again opened due to the upward movement of the gate arm 18 caused by energization of the motor winding 100. As previously mentioned, the circuit controller contacts 107 are closed below a seventy-eight degree position, thus conditioning the energizing circuit for the motor winding 100 upon energization of the motor control relay MC.

It can now be seen that the reason for enforcing a downward movement of the gate arm 18 to the seventy degree position is to permit the closing of the circuit controller contacts 106 so that the pick-up coil P and its associated electromagnetic latching device can once again be reactivated as the gate arm 18 passes through the seventy-five to eighty-seven degree position during its upward movement. Otherwise, the gate arm 18 would not be latched after it reaches its ninety degree vertical clear position and a gravity down movement could eventually occur. Also, a return of the gate arm 18 to the seventy degree position insures that the motor 50 is again rotating in a direction to move the gate arm 18 upward towards its vertical position before the pick-up coil P is again energized, which action starts occurring at the seventy-five degree position. The same procedure would be necessary during a power down movement of the gate arm 18. If for any reason the track relays R1 or R2 should be momentarily shunted and cause initiation of a downward gate arm movement, the gate arm would travel to the seventy degree position before reversing to an upward movement, thus permitting reactivation of the electromagnetic latching device.

From the foregoing description and with reference to the drawings it should be seen and understood that the present invention provides a highway crossing protection

system including many desirable features to insure the safe operation of traffic over both the railroad and the highway facilities, all of which are distinctly pointed out in the specification and illustrated on the drawings.

Having shown and described one specific embodiment of the highway crossing protection system of the present invention, it is desired to be understood that the form selected herein to facilitate the disclosure of the invention should not be limited to the specific showing herein as modifications, adaptations and alterations could be applied thereto without in any manner departing from the spirit or scope of the invention, except as limited by the appending claims.

What I claim is:

1. In a control system for a highway crossing gate, a hold-clear magnet for mechanically latching said gate in an upright vertical position when energized but releasing said gate to assume its gravity biased horizontal position when deenergized, a rotary contactor having contacts whose operation is governed by the angular position of said gate, a motor for driving said gate to its vertical position, circuit means for energizing said motor through contacts of said rotary contactor to drive said gate to a vertical position when a train has passed out of an approach section, means for energizing said hold-clear magnet initially only when the approach track section is unoccupied by a train and the gate is being operated to its vertical position by said motor, circuit means for maintaining said hold-clear magnet energized independently of the position of said rotary contacts when no train is in approach to said section providing that said hold-clear magnet has been initially energized.

2. An organization according to claim 1 in which the contacts on said rotary contactor controlling said circuit means for energizing said motor are of the snap acting type for quickly opening said motor circuit when said gate is raised to its vertical position.

3. In a system according to claim 1 in which there is relay means requiring said gate to assume at least a partial horizontal position before said circuit means for energizing said motor is effectively energized to restore said gate to a vertical position following the passage of a train out of the approach track section.

4. In a control system for a highway crossing gate, a motor for driving said gate to its vertical position, a rotary contactor connected to said gate and having cams for operating fixed contact fingers, a certain one of said cams being constructed to include a latch member for causing its contact finger to operate in a snap acting manner, and circuit means for energizing said motor through said snap acting contacts of said rotary contactor to at times drive said gate to a vertical position.

5. An organization according to claim 4 in which said cam includes a spring biased segment cooperating with a smoothly contoured cam for causing abrupt operation of its respective fixed contact when said cam is moved in one direction and to cause a smooth operation of said fixed contact when said cam is moved in the opposite direction.

No references cited.