American Railway Signaling Principles and Practices

CHAPTER XXIII

Highway Crossing Protection

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HIGHWAY CROSSING PROTECTION

History, theory and practice.

In the day of horse-drawn vehicles, adequate protection at highway crossings was afforded by placing conspicuous signs at the crossing, one sign generally sufficing for a single or double-track crossing, the lettering on the sign conforming with the ideas of various railroad officials, State laws or State authorities. It was required that the engine whistle be sounded at varying distances from the crossing—¼ mile being the most favored; the engine bell to ring until the train reached the crossing.

The speed of horse-drawn vehicles was such that to avoid arriving at the crossing at the same time as the train, they had to be quite close in order to hear either the engine whistle or the bell when the train was ¼ mile away. Further, the radius of travel of a horse-drawn vehicle was, except where people were touring the country, fairly short; the drivers knew the location of all the crossings and were familiar with the train service over each. For these reasons, accidents were infrequent. If any additional warning was required, crossing bells, and, in some cases, watchmen and gates, were provided.

With the advent of the automobile the entire situation changed. Drivers were, in many instances, unfamiliar with the local conditions. The speed of the automobile at times equalled the speed of the train. Noises incident to operation of the automobile, especially of trucks, prevented the driver from hearing the engine whistle, engine bell, and also the highway crossing bell far enough distant to stop short of the crossing.

According to the Bureau of Railway Economics statistics there were 252,507 grade crossings in 1921 and this number increased to 258,045 in 1924. During the same period 3,240 grade crossings were eliminated at an estimated cost of $194,400,000.00, giving an average cost of $60,000.00 per crossing. This is a very conservative figure.

The number of protected crossings increased from 40,779 in 1921 to 42,590 in 1924, and the number of unprotected crossings from 211,728 in 1921 to 215,455 in 1924.

According to 1917 Interstate Commerce Commission reports, 61 per cent of the casualties at grade crossings involved automobiles and by 1925 this figure had increased to 85 per cent. From 1917 to 1925 inclusive, there were approximately 12,000 people killed in grade crossing accidents in which automobiles were involved.

Recognizing these changed conditions, a special committee of the American Railway Association, Mr. James A. McCrea, Chairman

(then General Manager of the Long Island R. R.), was appointed in 1915 to make recommendations as to more adequate protection. Realizing that one of the fundamentals is uniformity, so that the information regarding the conditions may be given to the drivers and pedestrians in the same way at all crossings, the Committee recommended painting the crossing gates with black and white stripes; installation of standard Approach signs at a given distance from the crossing (these now being the well-known circular disc with white background and black cross and border, showing black letters "RR" on the white background); the display of red lights toward vehicular traffic on crossing gates and in the hands of the watchmen, and the well-known Stop sign to be used by the watchman during daylight. The report was adopted by the American Railway Association in 1916. The Committee also recommended regulations for the use of watchman's signal which were adopted by the American Railway Association. This Committee was continued from year to year as the Committee on Grade Crossing Protection and Trespassing, and, on August 3, 1921, Chairman C. L. Bardo requested the Signal Section of the American Railway Association to consider the question of standardization of mechanical or electrical devices installed at highway crossings as a substitute for crossing gatemen and flagmen, and make recommendations. Committee XX—Highway Crossing Protection, of the Signal Section, appointed June 5, 1921, Chairman J. B. Latimer, met in New York on November 18, 1921, and reported to the Signal Section in March 1922. The Committee again reported to the Annual meeting in June 1922. A part of the June 1922 report was approved by letter ballot.

In June 1922, the personnel of the Committee was changed and A. H. Rudd was appointed Chairman. At the 1923 Annual Meeting, the following resolution prevailed and was adopted as recommended practice:

> "That an electrically or mechanically-operated signal used for the protection of highway traffic at railroad crossings shall present toward the highway, when indicating the approach of a train, the appearance of a horizontally swinging red light and/or disc."

At the 1925 Annual Meeting, Requisites for Highway Crossing Signals were approved and adopted as recommended practice.

The Requisites for Highway Crossing Signals, as of date of issue of the chapter, are as follows:

Requisites for Highway Crossing Signals

1. *Aspect.*

An electrically or mechanically-operated signal used for the protection of highway traffic at railroad crossings shall present toward

the highway, when indicating the approach of a train, the appearance of a horizontally swinging red light and/or disc.

2. *Location.*

The railroad standard highway crossing sign and the signal shall be mounted on the same post. Either a signal of the flashing light type or one of the wig-wag type may be used, but both should not be placed on the same post. No lights, markers or signs, other than those provided in the requisites, shall be placed on this post.

3. *Operating time.*

Automatic signal devices used to indicate the approach of trains shall so indicate for not less than 20 seconds* before the arrival of the fastest train operated over the crossing.

Flashing Light Type

4. *Height.*

The lamp should preferably be not less than 6 feet nor more than 9 feet above the surface of the highway.

5. *Width.*

The two lamps shall be mounted horizontally 2 feet 6 inch centers.

6. *Flashes.*

Lights shall flash alternately. The number of flashes of each light per minute shall be 30 minimum, 45 maximum.

7. *Hoods.*

Lamp units shall be properly hooded.

8. *Range.*

When lamps are operated at normal voltage, the range, on tangent, shall be at least 300 feet on a clear day, with a bright sun at or near the zenith.

9. *Spread.*

The beam spread shall be not less than 3 degrees each side of the axial beam under normal conditions. This beam spread is interpreted to refer to the point at the angle mentioned where the intensity of the beam is 50 per cent of the axial beam under normal conditions.

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* Local conditions may require a longer operating time; however, too long an operation by slow trains is undesirable.

10. *Lenses or roundels.*

Size shall be 5⅜ inches minimum, 8⅜ inches maximum.

11. *Transmission values (for red lenses and roundels).*

Based on A.R.A. standard scale, should be 150 to 220 where plain cover glass with reflector is used; 220 to 300 where signals are used without reflectors or where the ribbed Spreadlite lens is used in front of the reflector.

12. *Short range indication.*

Signal shall display a satisfactory short range indication.

13. *Peep holes.*

Peep holes may be used.

Wig-Wag Type

14. *Length of stroke.*

Length of stroke is the length of chord which subtends the arc, determined by the center of the disc in its extreme positions, and shall be 2 feet 6 inches.

15. *Disc.*

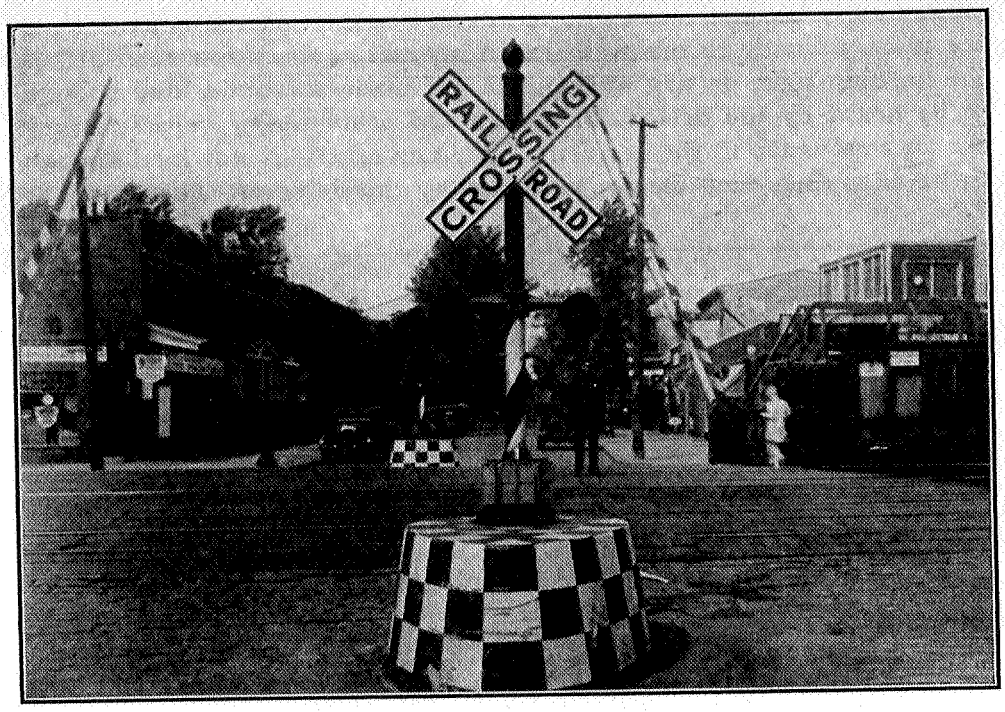
Size and painting of disc shall be as shown on A.R.A. Sig. Sec. 1553.

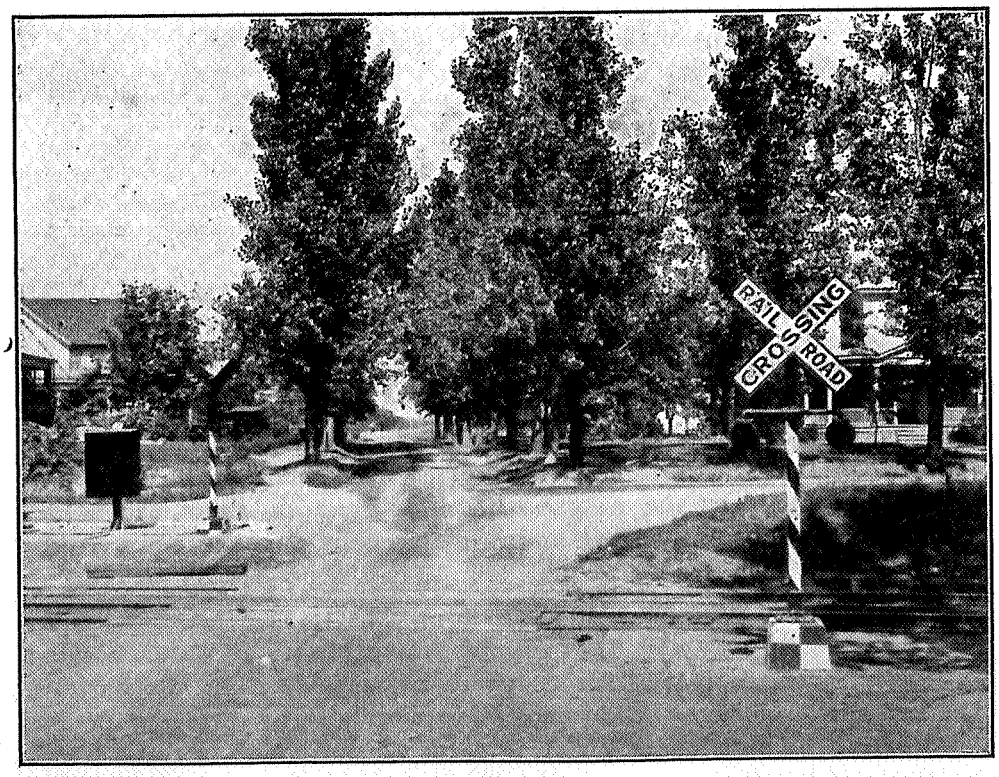
16. *Number of cycles.*

Movement from one extreme to the other and back constitutes a cycle. The number of cycles per minute shall be 30 minimum, 45 maximum.

Flashing light and wig-wag highway crossing signals were presented at the 1927 Annual Meeting and are now recommended practice. In the flashing light type the lights flash alternately, giving the appearance of a swinging light, the number of flashes per minute being practically the same as the number of swings of the wig-wag disc. It will therefore be observed that all types of highway crossing signals give the same information in practically the same way, particularly at night when most needed.

Signals of the flashing light type have been favorably received in the eastern part of the United States, very few wig-wag signals being installed. In the western part of the United States, signals of the wig-wag type have been installed for many years and uniformity will be better attained by continuing the installation of this type. In the southern part of the country various types of signals have been used and a standard can only be attained by substituting either the flashing light or the wig-wag type; most roads are installing the former. In Canada the wig-wag type is used generally.


RAIL
ROAD
CROSSING


RAIL
ROAD
CROSSING

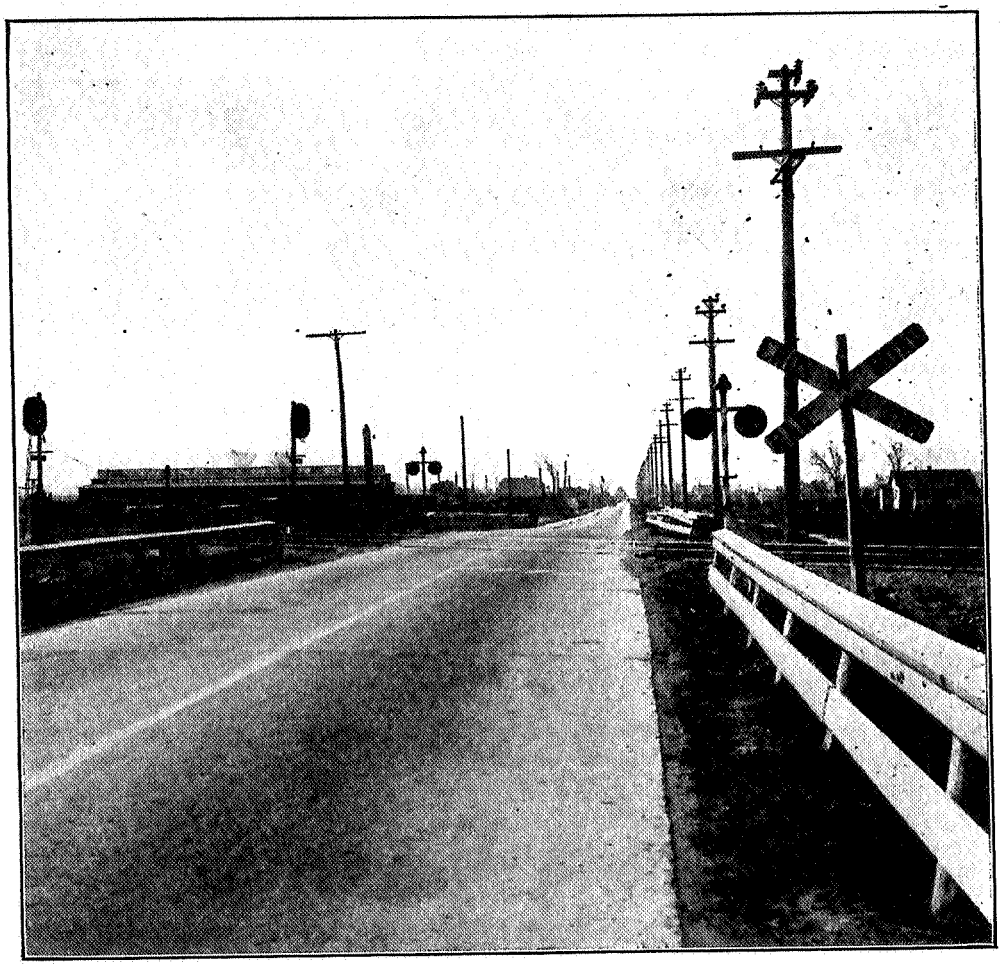
The Special Committee on Highway Crossing Protection has not made any recommendations as to the use or non-use of bells. Bells are more difficult to maintain in an operative condition than either the flashing light or wig-wag signal. If made to sound loud enough to be heard by the drivers of trucks and other heavy vehicles, they are an annoyance to the residents and, conversely, if not loud enough to be annoying, they cannot be heard by the drivers. Therefore, as

a protection for automobile traffic, they are not of sufficient value to warrant their installation. However, where pedestrian traffic is heavy, especially in the neighborhood of schools, their use as an adjunct to the visual signal and for the sole purpose of warning pedestrians is in some cases justified. They need not be so loud as to cause annoyance.

The American Railway Engineering Association has recommended a standard crossbuck sign for use with signals of either the flashing light or wig-wag type. This sign is smaller and of different design than the more conspicuous crossing sign recommended for use where

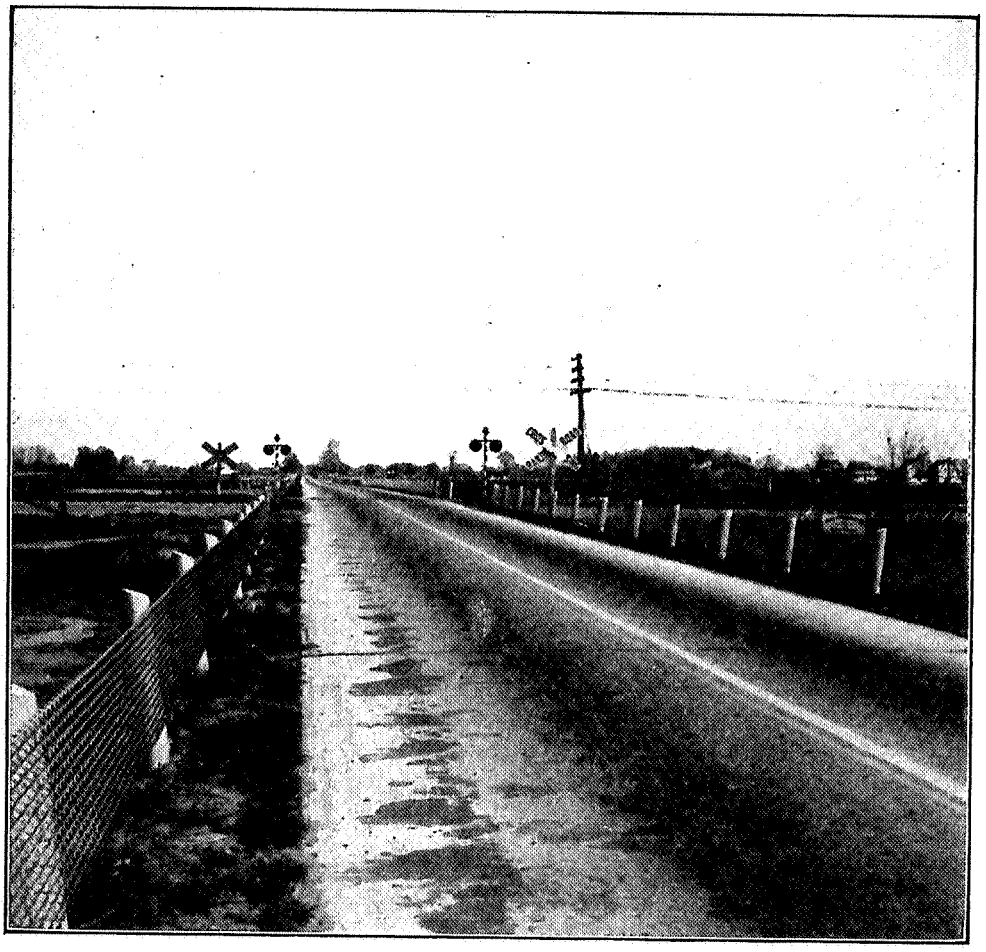
there are no signals to indicate the approach of trains. The recommendations of the Signal Section in regard to the height above the street level should be complied with.

One remaining problem, on which standardization is doubtful for a considerable length of time, is the location of these signals with respect to the vehicular traffic. Some Public Service Commissions desire them located in the center of the highway; in several States,



the Highway Commissions refuse approval of such location on account of the obstruction in the highway. In other States, both the Highway Departments and the Public Service Commissions desire the signals located preferably to the right of the road. In cities and towns where traffic signals are located in the center of the highway, the center is probably the logical point to place the highway crossing signal, while in the open country, it would seem better to place them at the side of the road, preferably to the right where drivers naturally look for signs.

The theory of highway crossing protection is that a driver shall first be apprised by an Approach sign (which may perhaps in the future be illuminated, as more and more highways are being lighted) that he is approaching a crossing; second, by some indication, preferably a reflecting sign close to the crossing, that there is no signal to indicate the approach of trains, and that he must by his own alertness protect himself; and third, by the display of flashing light or wig-wag signals at the crossing which indicate the approach of trains.



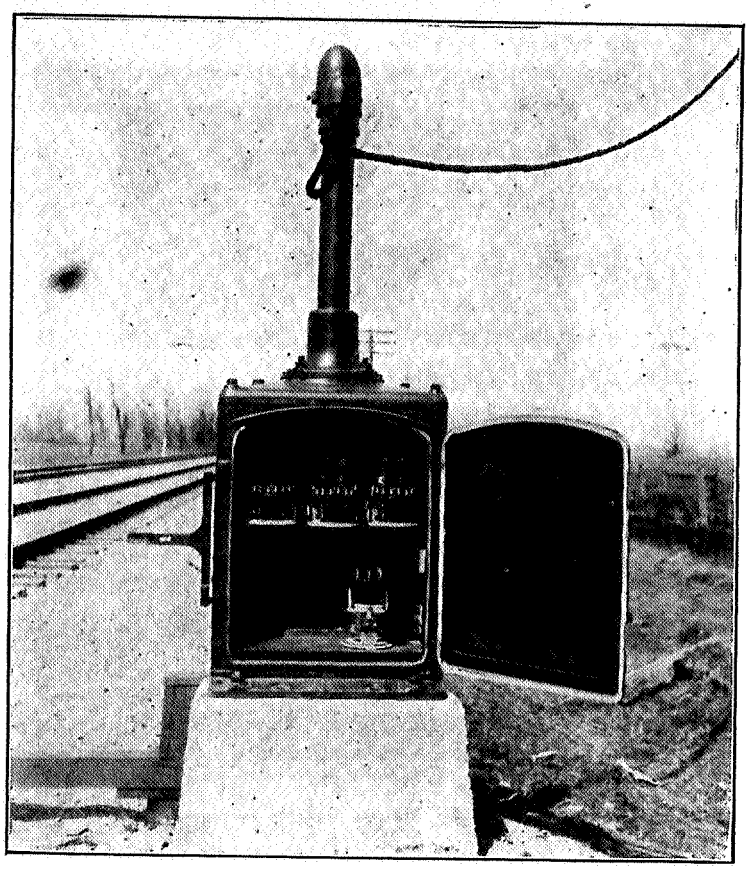
In a number of localities, the authorities have requested the substitution of highway crossing signals for crossing watchmen, on the basis that they are more reliable than the human agency and, in other localities, in place of gates, especially where such gates were operated only part time, recognizing that a raised crossing gate is one of the most insidious invitations to highway users to cross the tracks and that the crossing is particularly dangerous when the gates are unattended.

The practice of painting on hard roads two parallel lines with letters "R.R." between them approaching the crossing, and stripes, similar to those on a crossing gate nearer the railroad, is highly commendable. This painting is being rapidly extended and is growing in favor. This marking is ideal but may be obscured by snow and it is not applicable to dirt roads. As an adjunct to other signals it is invaluable, and in some of the Southern States should, in many cases, be all the approach warning needed.

Many suggestions have been made that additional approach warning be given. Changes in the highway surface or alignment, obstructions in the center so that vehicles must slow down to drive around them, sharp reverse curves on both sides of the railroad and roughening the surface so that automobiles will be forced to reduce speed have been advocated. It is claimed that such devices would tend to concentrate the driver's attention on the immediate handling of his automobile and take his attention entirely away from the railroad crossing. It now is the consensus of the best informed that the

safest crossing is the straightaway, smooth and level one so automobiles can be handled to the best advantage and which reduces the possibility of stalling on the crossing to a minimum.

Some States have laws requiring vehicles to stop before crossing. However, away from towns and cities where the view is good, there is no need for such stop except for the purpose of obeying the law, and the tendency of the driver is to keep going, as no danger is involved.



It is good psychology that an unnecessary or unreasonable requirement is not obeyed as well as one wherein the reasonableness appeals to the public, and, in many places, such laws cannot be obeyed without tying up traffic. Slowing down is better if drivers can be educated to shift to low gear to prevent possible stalling on the crossing.

An ideal arrangement of signals in addition to marking the highway would be the equipment of every motor vehicle, with a low light on the right side, shielded from view of approaching vehicles, with rays focused on or near the ditch, Approach signs of standard size and appearance equipped with a reflecting surface, similar signs

at the crossing, and in addition flashing light or wig-wag signals where local conditions warrant such protection.

The possibilities of the flashing light or wig-wag highway crossing signal are not yet generally recognized.

Several types of automatic gates are being exploited. Some have been installed. Their use introduces dangers. Highway crossing signals, on the other hand, do not drop on a vehicle or impose a sudden barrier as vehicles approach the crossing, or a barrier to prevent the driver of such vehicles from leaving the crossing. Remote control of gates has been advocated, but such control introduces dangers, whereas the remote control of crossing signals is feasible and would be, in many cases, advantageous. Highway crossing signals are operated in the majority of cases by track circuits on main

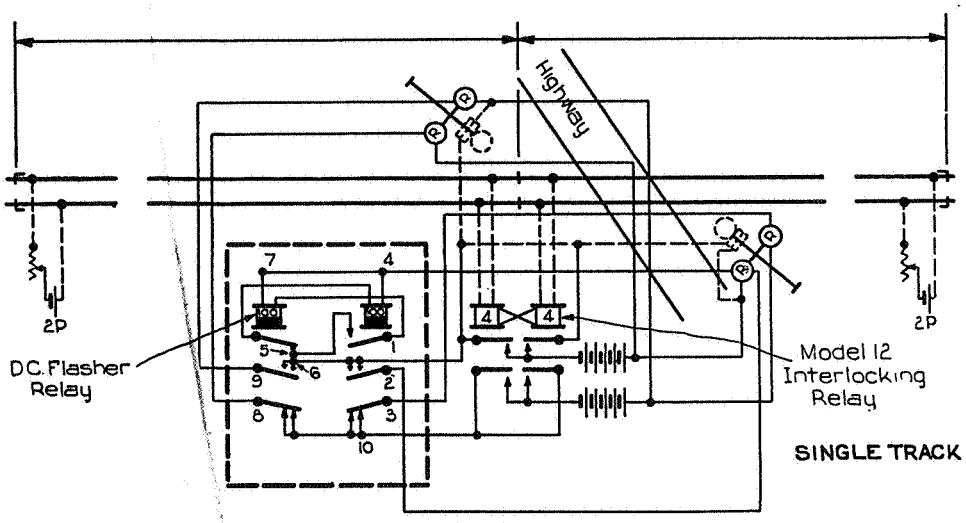


Fig. 1.
Typical Circuits for Light Signals on Single Track.

tracks; most of those now in operation on double or more tracks being operated in the direction of traffic only, although in recent installations they are made operative by trains in either direction. Movements on sidings do not operate these signals, such movements being protected on most railroads by the trainmen acting as watchmen. Where switching is done within the circuit, the signals sometimes give misleading information. The operation of such signals non-automatically, that is, controlled by a watchman at some central point, and protecting five or six crossings on the approach of a train or when shifting is being done, is entirely feasible and, by such use, protection would be given for movements on sidings as well as on main tracks. Instead of having a signal start to operate at a fixed point, regardless of the speed of the train, the crossing watchman using good judgment can afford as much and perhaps more protection than an automatic device, and, at the same time, facilitate traffic on the highways.

Flashing Light Signals

A flashing light signal consists of two lamps mounted 2 feet 6 inches center to center on a horizontal support arm fastened to a pipe or concrete post 6 to 9 feet from the ground.

Each lamp unit consists of a cast-iron case which houses the electric lamp. In the front of the case is a red lens and cover glass. A hood is placed above the cover glass to obscure the direct rays of the sun.

One signal is placed on each side of the track, facing travelers on the highway as they approach the crossing and either to the right or in the center of the road, as local conditions permit.

In some cases, where two or more streets intersect at or near the crossing, it is necessary to place additional lamp units to protect traffic on all streets.

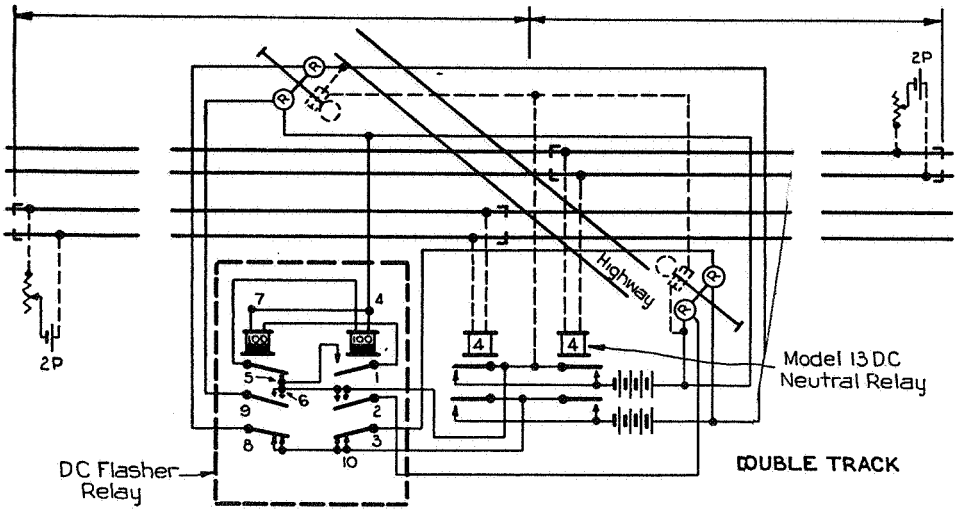


Fig. 2.
Typical Circuits for Light Signals on Double Track.

When operating, the lights on each set of lamp units flash alternately and are timed so as to present the appearance of a horizontally swinging red light. The number of flashes per minute should be between 30 and 45.

The flashing of lights alternately is accomplished by means of a flasher relay through which the light circuits are opened and closed alternately. The flasher relay is described in detail in Chapter VI—Direct Current Relays.

Current is fed to the lights through the flashing relay from another relay or controlling switch, the contacts of which are closed when a train is approaching.

The standard method of wiring requires that in case the flasher relay fails to operate, at least one light on each signal will burn constantly.

The signals may be controlled automatically or manually.

Probably the simplest and most common form of automatic control on single track is by means of an interlocking relay, both sides of which are connected to, or controlled through, track circuits extending in both directions the proper distance from the crossing. With this type of control, the signal operates from the time a train enters the operating section until the rear of the train passes the crossing. The directional operation is accomplished through the interlocking feature of the relay. The interlocking relay is described in detail in Chapter VI—Direct Current Relays.

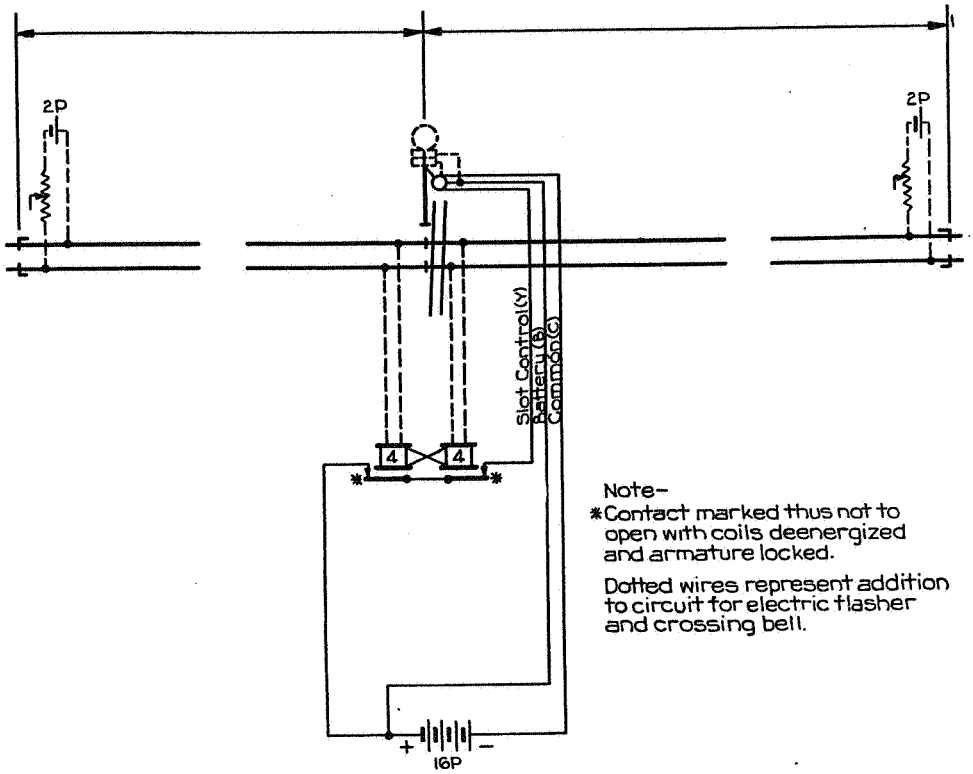


Fig. 3.
Direct Current Automatic Flagman with Direct Current Track Circuits.

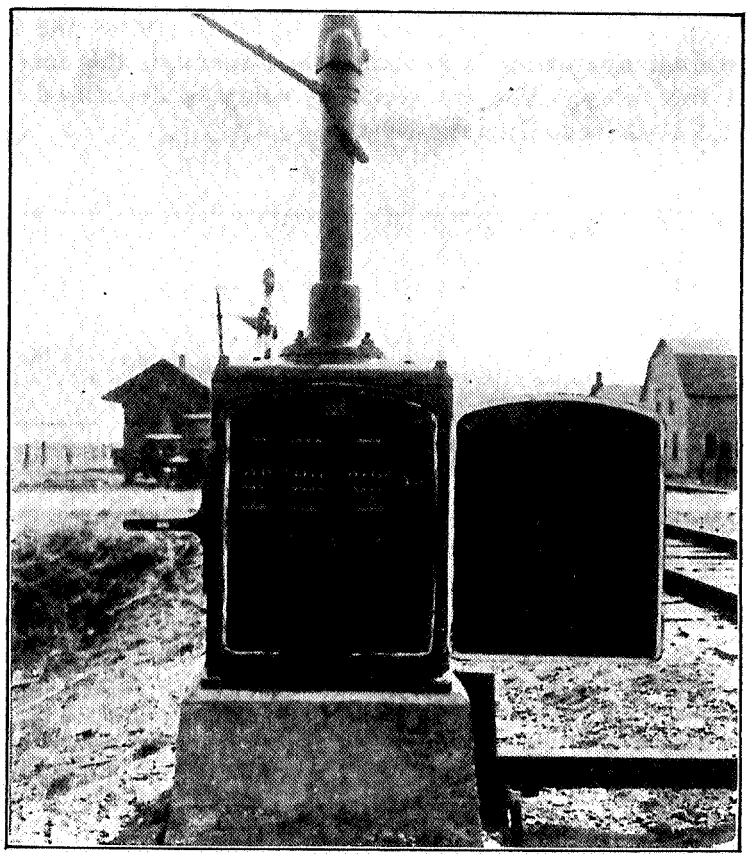
There are several schemes of automatic control in use, some of which are illustrated in Figs. 1, 2 and 3.

A manually-controlled signal operates when crossing watchman closes the controlling switch and cuts out when he opens it.

Unless alternating current is available, the cost of operating flashing light signals is high, as the only alternative is the use of primary batteries.

With alternating current available, very low operating cost is assured; however, "stand-by" equipment must be provided to insure continuity of operation when the power is off.

The "stand-by" equipment may consist of primary or storage batteries. When storage batteries are used they are usually charged by what is termed the alternating current floating method, which method is described in Chapter IX—Rectifiers.



Wig-Wag Signal

A wig-wag signal usually consists of a round disc fastened to one end of a rod, the other end being pivoted, and operated electrically. In the center of the disc a lamp with red cover glass is provided for the night indication. When operating, the disc swings horizontally.

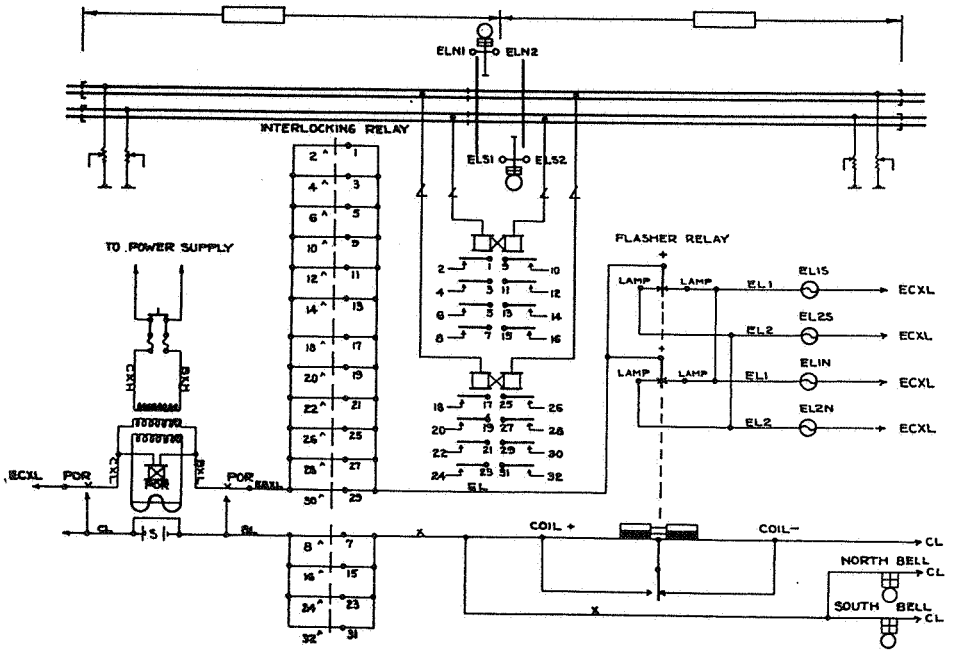
There are two types of operating mechanisms used: motor-driven and magnetic. The magnetic type is favored by several roads on account of the absence of gears and other parts which require frequent replacements.

These signals are made to operate on either alternating or direct current at various voltages.

The control of the signal, other than local wiring, is the same as for flashing light signals.

Maintenance

1. Voltage at lights must be maintained at prescribed value.
2. Battery and relay housing must be kept clean.
3. Wiring must be inspected and checked at regular intervals.
4. All parts of apparatus exposed to the weather must be kept painted.
5. Lamp supports must be adjusted so that a good view from the highway is secured.
6. Relays must be inspected frequently and tested at regular intervals.
7. All electrical connections must be kept clean and tight.
8. All moving parts of mechanism must be lubricated as specified by the manufacturer.
9. Operating mechanism must be kept in proper adjustment.
10. Signals should be tested or observed daily to insure reliable operation and record of performance made.

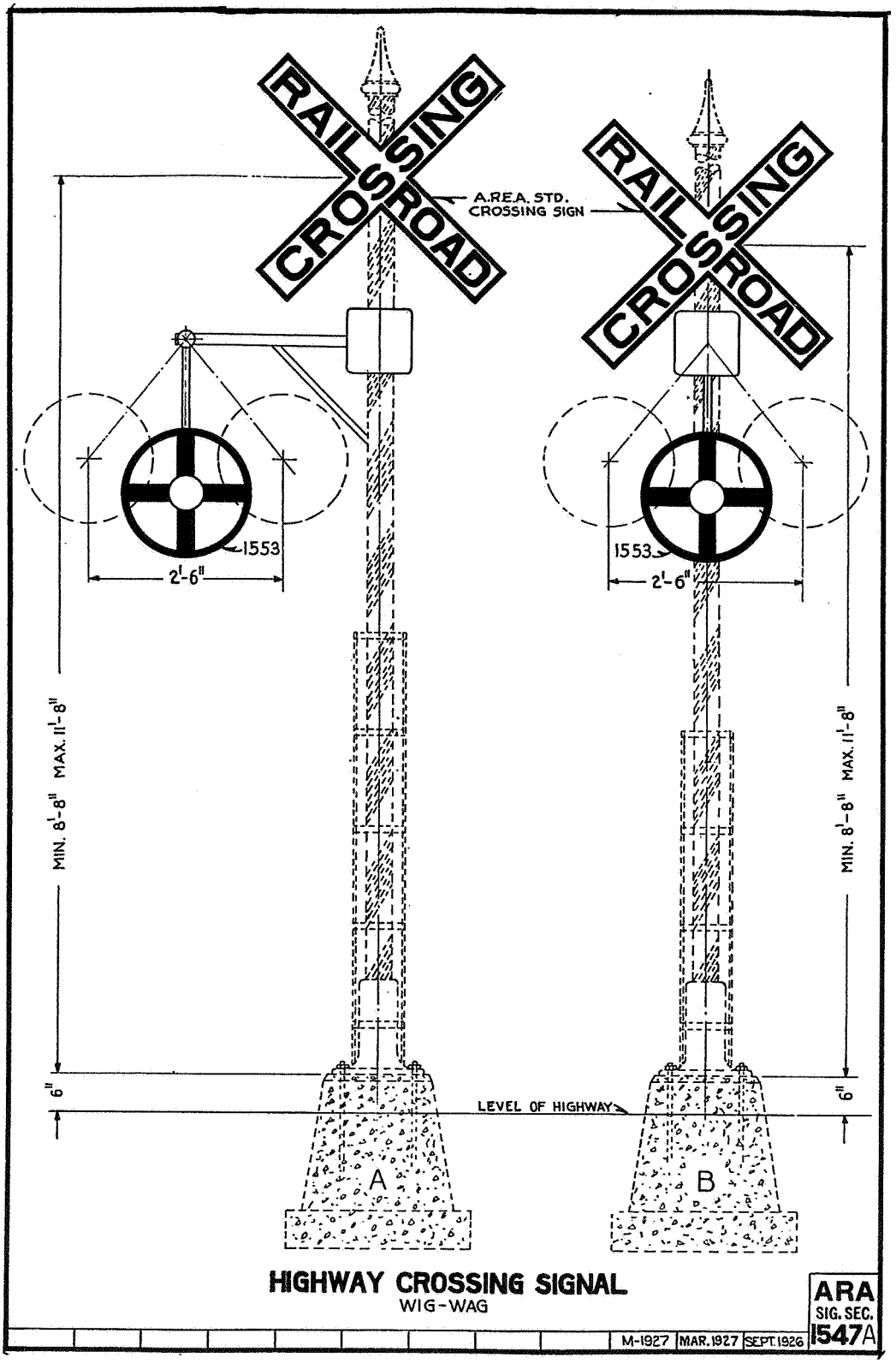


Typical Circuits for Flashing Light Signals.

Highway Crossing Gates

Where vehicular traffic is heavy, as on some city streets, manually-operated gates are used generally.

When a train is approaching the crossing, the watchman lowers the gates across the highway, thereby holding traffic until the train has passed over the crossing.



HIGHWAY CROSSING SIGNAL
WIG-WAG

ARA SIG. SEC. 1547A

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There are three types of gates in general use today: namely, pneumatic, mechanical and electric.

Pneumatic gates are operated by compressed air which is controlled by the watchman by means of valves. In most cases, the air is pumped by hand, but at busy crossings motor-driven compressors are used, or air is obtained from an air line used for other purposes.

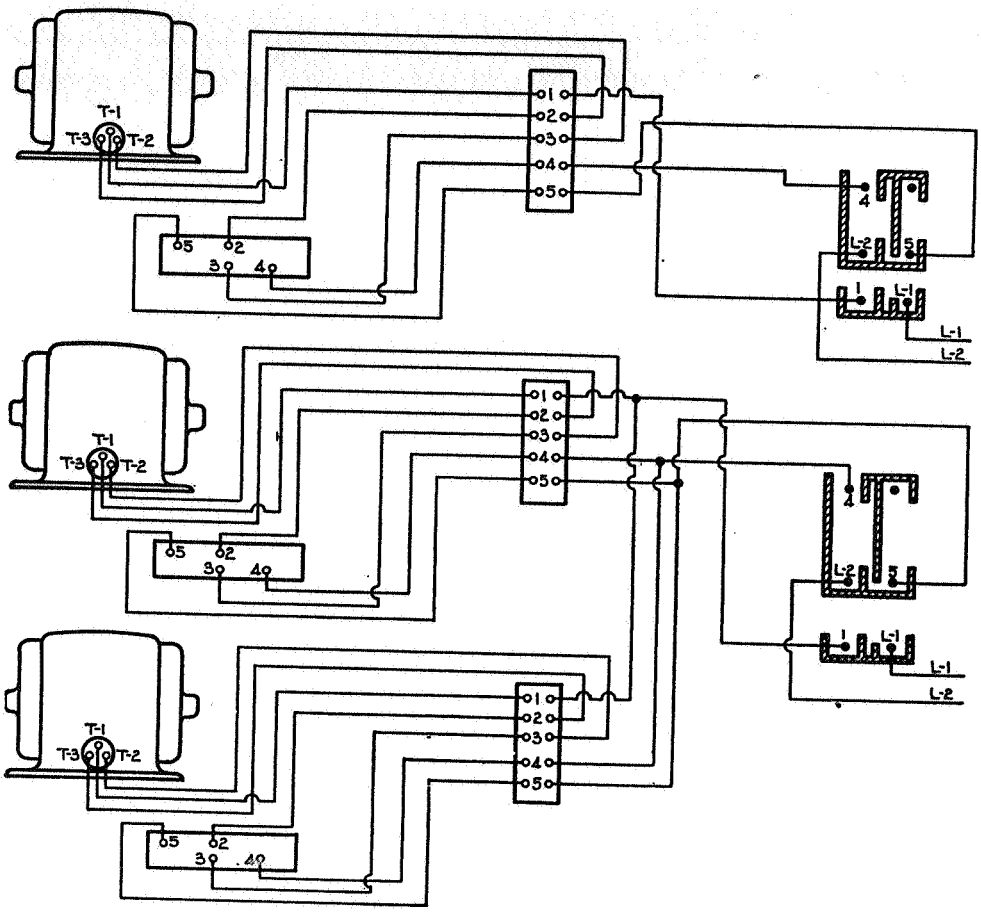


Fig. 4.
Wiring Diagram for Direct Current or Single-Phase Alternating Current Motors.

Mechanical gates are either pipe, wire or chain connected to operating levers or cranks.

Electric gates are operated by individual electric motors which are controlled by hand switches or other controllers. Typical circuits for electric crossing gates are shown in Figs. 4 and 5.

Crossing Watchman's Annunciators

In order that the watchman may be warned of the approach of a train in ample time to lower his gates where the view of the railroad is obscured, annunciators are sometimes provided.

Annunciator may be a bell, or buzzer, manually controlled by a watchman at another street, or it may operate automatically when a train approaches. In some cases, visual indicator in addition to the bell or buzzer is provided.

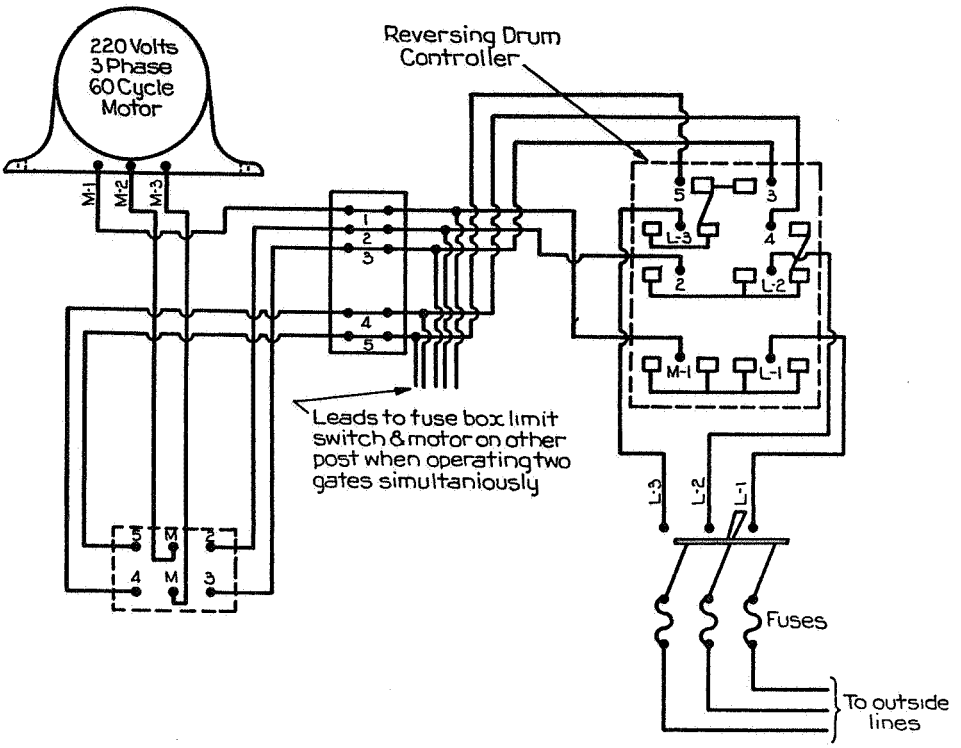
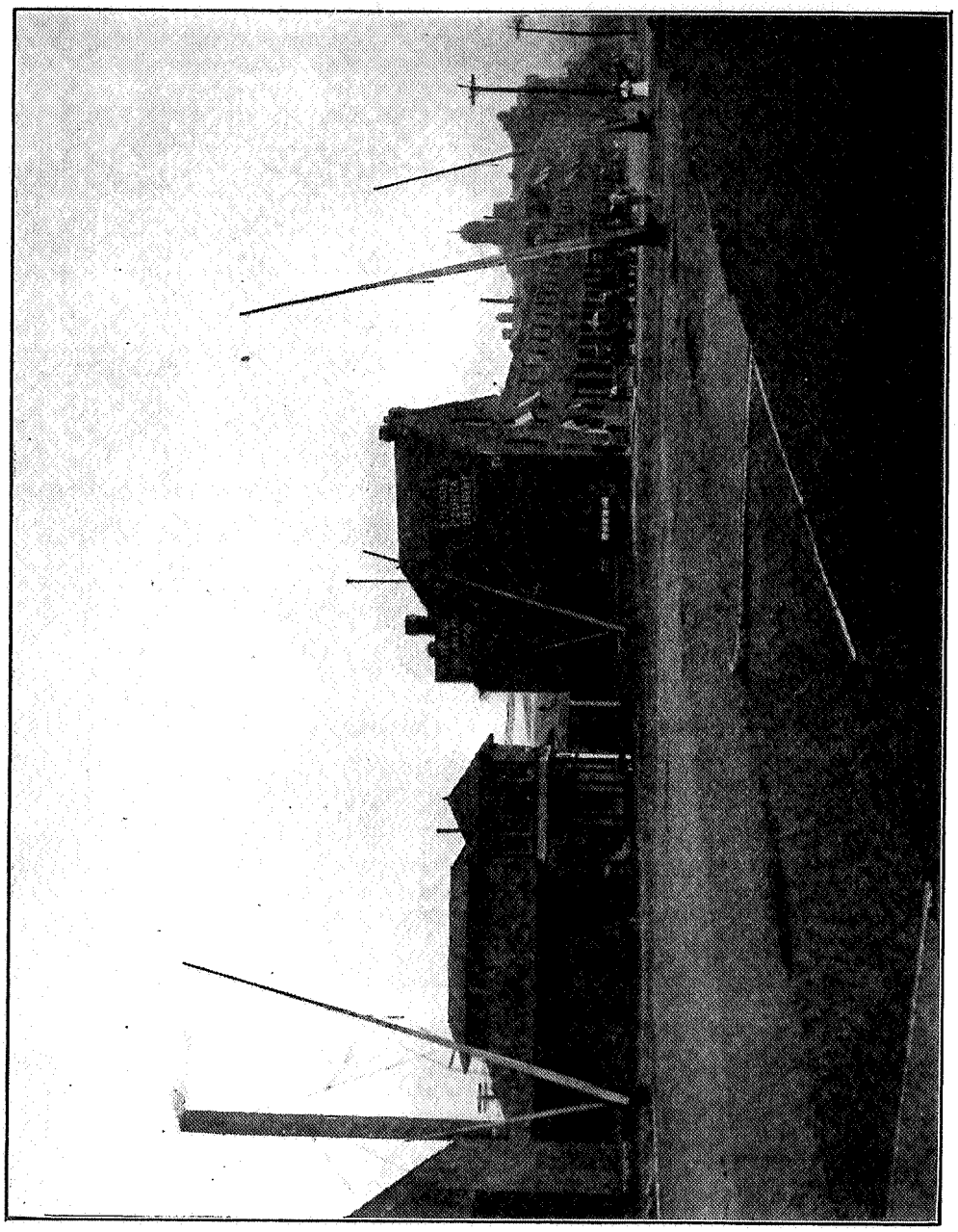


Fig. 5.
Wiring Diagram for Three-Phase Motor.



American Railway Signaling Principles and Practices

QUESTIONS ON

CHAPTER XXIII

Highway Crossing Protection

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HIGHWAY CROSSING PROTECTION

Requisites for Highway Crossing Signals

Aspect.

1. Define a highway crossing signal.

2. What aspect shall be presented towards the highway when indicating the approach of a train?

Location.

3. Shall the railroad standard highway crossing sign and the highway crossing signal be mounted on the same post?

4. May a flashing light type and a wig-wag type signal be mounted on the same post?

5. May lights, marker or signs, other than those provided in requisites, be placed on the post?

Operating time.

6. How long a time shall automatic signal devices indicate before the arrival of the train at crossing?

7. Is the time based on the fastest or slowest train operating over the crossing?

Flashing Light Type

Height.

8. What distance above surface of highway should lamps be placed?

Width.

9. How shall lamps be mounted?

10. What should be the distance between lamp centers?

Flashes.

11. Shall lights flash alternately or simultaneously?

12. What shall be the minimum and maximum number of flashes per minute per light?

Hoods.

13. Shall lamps be hooded?

Range.

14. What range shall a lamp have on tangent, on a clear day with a bright sun at or near the zenith, when operated at normal voltage?

Spread.

15. What shall be the beam spread of lamp, each side of axial beam under normal conditions?

16. To what point is this beam spread interpreted to refer?

Lenses or roundels.

17. What shall be the minimum and maximum size of lenses or roundels?

Transmission values (for red lenses and roundels).

18. Based on A.R.A. standard scale, what shall be the transmission values for red lenses and roundels:

(a) when plain cover glass with reflector is used?
(b) when reflector is not used?
(c) when ribbed Spreadlite lens is used in front of reflector?

Short range indication.

19. Shall signal display a satisfactory short range indication?

Peep holes.

20. May peep holes be used?

Wig-Wag Type

Length of stroke.

21. What is known as length of stroke?

22. How is the length of stroke determined?

23. What shall be the length of stroke?

Disc.

24. What shall be the size and painting of disc?

Number of cycles.

25. What constitutes a cycle of movement?

26. What shall be the minimum and maximum cycles per minute?

Flashing Light Signals

27. Describe a flashing light signal.

28. Of what does each lamp unit consist?

29. Why is a hood used?

30. How are signals located in respect to highway and track?

31. When may additional lamp units be necessary?

32. Shall lights on each set of lamp units flash alternately or simultaneously?

33. What aspect shall the flashes represent?

34. What shall be the minimum and maximum number of flashes per minute per lamp?

35. How is the flashing of lights, alternately, accomplished?

36. Through what is current fed to lights?

37. What does the standard method of wiring require in case the flasher relay fails to operate?

38. How may signals be controlled?

39. What is the simplest and most common form of automatic control on single track?

40. With this type of control, when does the train operate the signal?

41. How is directional operation accomplished?

42. How is a manually-controlled signal operated and cut out?

43. Why is commercial current used generally?

44. Why is stand-by service provided?

45. Of what does stand-by equipment consist?

46. When storage batteries are used, how are they usually charged?

Wig-Wag Signal

47. Of what does a wig-wag signal usually consist?

48. How is the night indication provided?

49. When operating, how does the disc swing?

50. What two types of operating mechanisms are used?

51. Are these signals designed to operate on alternating or direct current at various voltages?

52. How does the control of this signal, other than local wiring, compare to the flashing light signal?

Maintenance

53. At what value must voltage at lights be maintained?

54. In what condition must battery and relay housing be kept?

55. At what intervals must wiring be inspected and checked?

56. What parts of apparatus must be kept painted?

57. How must lamp supports be adjusted in respect to the highway?

58. How often must relays be inspected and tested?

59. In what condition must electrical connections be kept?

60. How must moving parts of mechanism be lubricated?

61. Is proper adjustment of mechanism necessary?

62. How often should signals be tested or observed to insure reliable operation and record of performance made?

Highway Crossing Gates

63. When are crossing gates used generally?

64. How is highway traffic controlled by crossing gates?

65. Name the types of gates in general use?

66. How are pneumatic gates operated?

67. How is the air used for the operation of gates generally obtained?

68. How are mechanical gates connected to operating levers or cranks?

69. How are electric gates operated?

Crossing Watchman's Annunciators

70. Under what conditions are annunciators used?

71. What type of annunciator may be used, and how is it controlled?

72. What is used in addition to an annunciator in some cases?